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# Skyways

Flight Operations • Business Commercial Military

NOVEMBER 1955

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Pilot's Report: Cessna 172

■ Decca for Copter Navigation

Flight Operations Round Table: Copilots on Twin-Engine Aircraft

50¢

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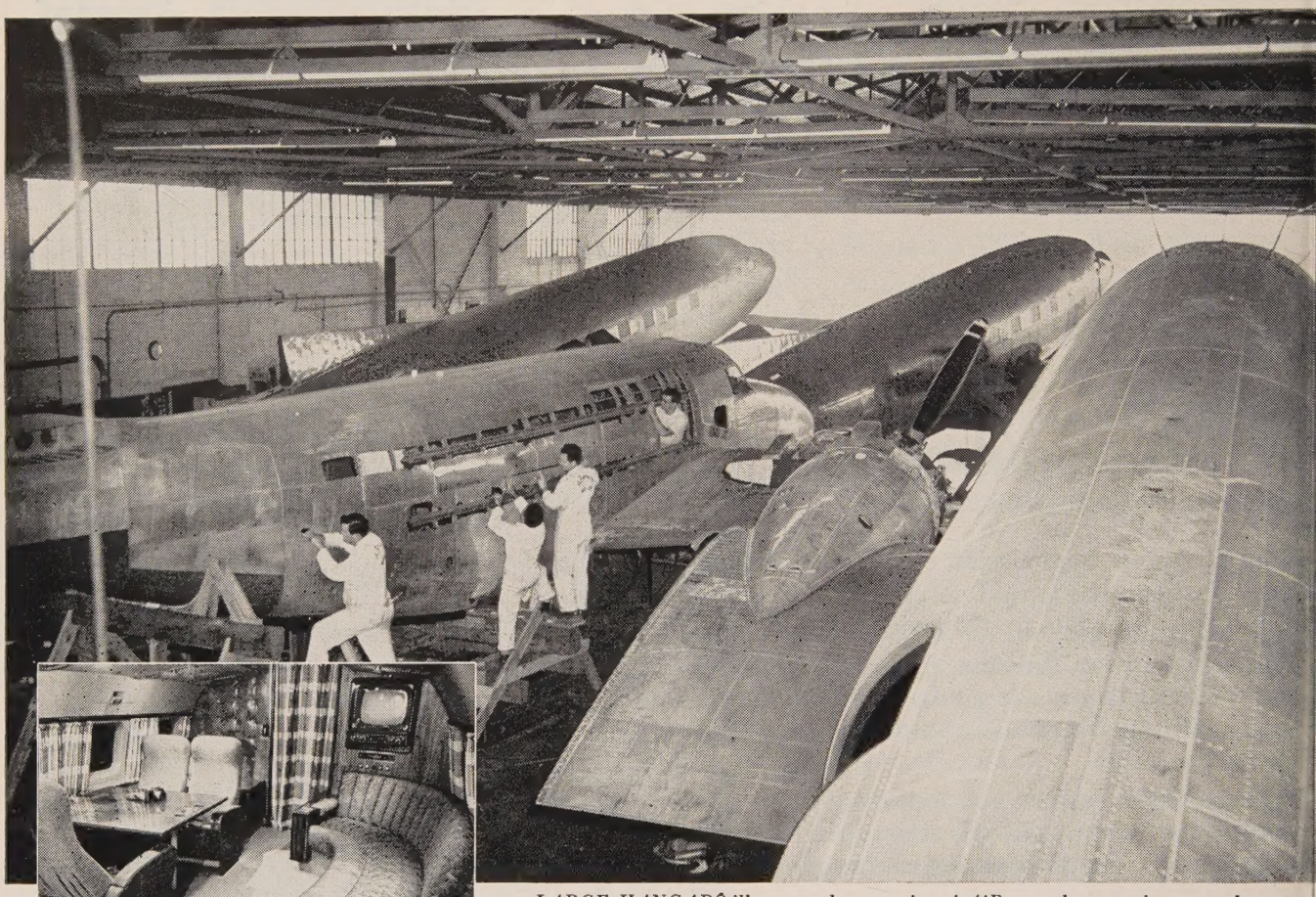

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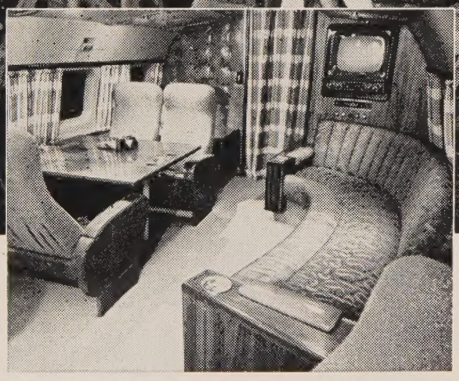

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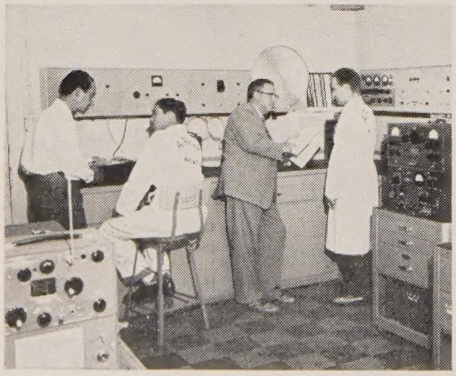

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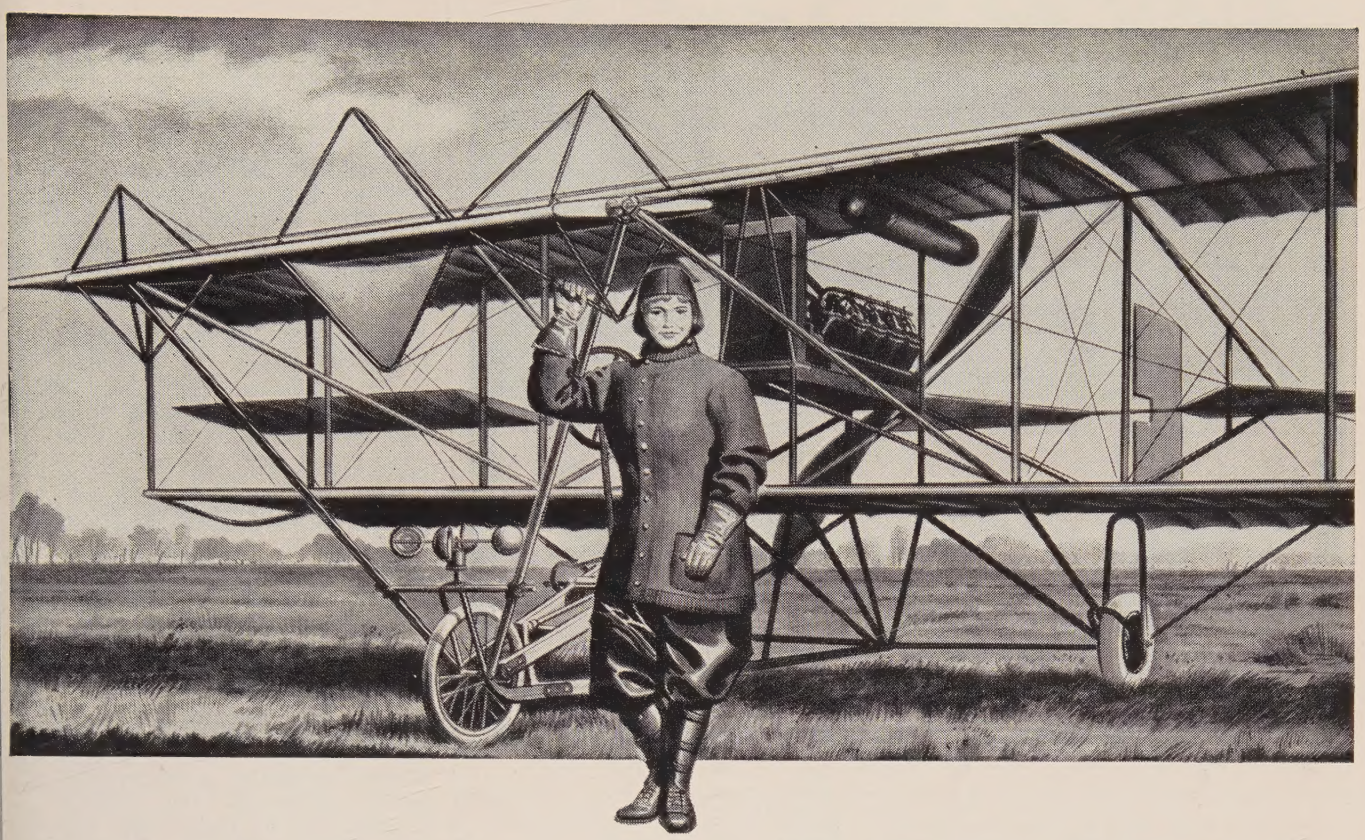

# The Young Lady on the Flying Trapeze

On September 2, 1910, Miss Blanche Scott, "an attractive and well-built aviatrix of Rochester," made the first solo flight by an American woman. Her plane, much like the contraption above, contained tricycle gear and an anemometer over the nose wheel (probably to tell the pilot when he was moving ahead), ranked as a mechanical marvel of the era.

We salute the courage of early-day flyers in embarking in these open-plumbing masterpieces, and regret BEECHCRAFTS were not available in those days. We would have liked to have offered demonstrations of the comfort, convenience and safety that modern-day pilots accept as a matter of course.

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# industry notes...

■ Allison Division of General Motors has received an order from American Airlines for Model 501 turboprop engines, rated at 3,750 hp, to power the Lockheed *Electras* being built for American. This initial order, valued at more than $12,500,000, is for the commercial version of the military T56 engine which powers the *Hercules*.

■ The world's speed record for helicopters was broken recently by McDonnell Aircraft's experimental convertiplane. Officially labeled the XV-1 and flown by John R. Noll, the convertiplane attained a forward speed of 180 mph. Previous speed record for copters was 156 mph. The XV-1 is powered by a Continental engine.

■ The Navy's newest aircraft carrier, the *USS Saratoga*, packs enough power to drive more than 100 passenger locomotives. The *Saratoga's* propulsion equipment develops over 200,000 hp and will drive the 60,000-ton carrier at a top speed "in excess of 30 knots," or more than 34 mph. The new marine powerplant was designed and developed by the Navy and General Electric. In addition to this powerful propulsion equipment, the *Saratoga is* equipped with an angled flight deck and steam catapults. She was christened last month at the New York Naval Shipyard.

■ In the United States some 85% of all who use the common carriers (airline, railroad or bus) to travel 1500 miles or more, travel on the nation's airlines, according to an announcement by Brig. Gen. Milton W. Arnold, vice president of the Air Transport Association. He also reported that passenger revenues of the U.S. scheduled airlines during 1954 topped railroad passenger revenues, not including local commuting, for the second year.

■ The largest order for cargo aircraft in commercial aviation history was completed recently by the signing of a $20,000,000 contract by The Flying Tiger Line for delivery of 10 Lockheed *Super Constellation* air freighters. This order increases Lockheed's commercial cargo plane backlog to $40,000,000. Power for the *Super Connie* is provided by four Wright turbo-compound engines delivering 13,000 hp, eight times that of an average diesel freight locomotive. Cargo plane has a total fuel capacity of 6,550 gallons, enough to run an average automobile some 100,000 miles.

■ Said to be the most powerful jet engine in the world, the de Havilland *Gyron* recently passed the British Government's type-approval test at an initial thrust rating of 15,000 pounds. The engine is 154 inches long and its over-all diameter, less accessories, is 46¼ inches. *Gyron* was designed specifically for aircraft which will operate in excess of the speed of sound.

■ A $5,000,000 contract for the production of an advanced type automatic navigation system recently was awarded Ryan Aeronautical by the U.S. Navy. With this new equipment, development of which began four years ago and which is known as

# industry notes . . .

AN/APN-67, Navy planes can fly to any point on the earth's surface without relying on ground facilities, favorable weather conditions, or the availability of aerological data. The Ryan automatic navigator employs continuous wave radar techniques; is completely contained within the aircraft.

■ Eastern Air Lines has placed an order with Lockheed Aircraft for 40 propjet *Electras;* in addition Eastern took an option on 30 more *Electras.* The *Electra* will be 75 mph faster than today's crack transports. It has a top speed of 450 mph; cruises at 414 mph; has a service ceiling of 35,000 feet, a rate of climb of 2,950 fpm. Permissible take-off weight is 98,500 pounds, including 4,178 gallons of fuel. Maximum landing weight is 88,600 pounds. The EAL version will vary from 66 deluxe seats to 91 in the tourist configuration, plus a six-seat lounge in the rear. Cargo capacity is 558 cubic feet.

■ Navy officials and Martin engineers are reported to be "exceptionally pleased" with the flight tests of the Navy's new multi-jet seaplane, the Martin XP6M-1 *SeaMaster.* Thus far the airplane has logged over 25 flying hours. Intended as a mine-laying and photo reconnaissance aircraft, the *SeaMaster* is powered by four Allison J71 turbojet engines with take-off afterburners. It has a designed cruising altitude of 40,000 feet and, on tactical missions, can carry a 30,000-pound payload. Navy reported aircraft to be "unusually promising."

■ The first Fiberglas agricultural airplane, a farm utility model, recently came off the Taylorcraft, Inc., production lines. Called the *Topper,* it was designed for dusting and spraying, but can also be used as a personnel carrier or a cargo plane. It is powered by a 225-hp Continental engine and its CAA certified allowable gross weight is 3,767 pounds.

■ Grumann Aircraft's F11F-1 *Tiger* was the first jet to adopt the new concept of the "pinch-waist" design, called "area rule." This "area rule" concept which results in a fuselage shape often described as "coke bottle," "wasp-waist" or "Marilyn Monroe," has been applied to the *Tiger* and the Convair F-102A. The "area rule" is a rational way of reducing the sharp drag rise which occurs at transonic speeds. Work on this theory began in 1951 and has been a closely guarded Defense Department secret for some time. The "area rule" was developed by Richard T. Whitcomb, a 34-year-old research scientist for the National Advisory Committee for Aeronautics at its Langley Aero Laboratories.

■ North American Aviation has designed and put into service a new type jet-engine starter which takes its power directly from a gasoline engine through a hydraulic torque converter and starts engines much faster than presently used models. The new device looks like a sleek, low-slung sports car, and will replace more expensive starter types which utilize the air-turbine principle of operation.


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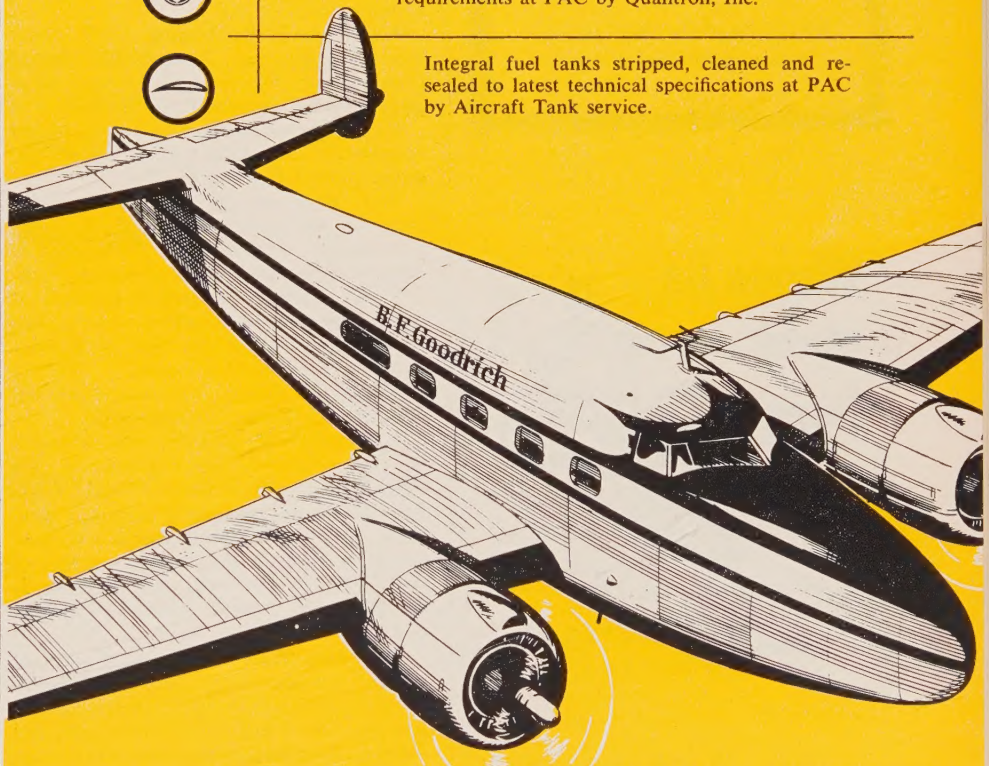


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## PERSONNEL

**John R. Wiley** has been named Director of Aviation of The Port of N.Y. Authority to succeed **Fred M. Glass** who has resigned to enter private industry. **Marshall D. Kochman** succeeds Mr. Wiley as Deputy Director of Aviation for the Port Authority.

**William J. Martin** has been named manager of Convair's F-102A production flight test facility at Palmdale, Calif. **Rex Warden** is chief pilot at Palmdale, and **W. H. Rumbaugh** has been named chief of field operations.

**Andrew Kalitinsky** has been appointed manager of the nuclear research and development department at Convair's Fort Worth plant.

**John H. Sidebottom,** engineering manager of Flight Refueling, Inc., recently was elected vice president of the company.

**John Attinello** is now assistant chief of research in Preliminary Design at the Fairchild Aircraft Division. He was formerly head of Navy BuAer's supersonic aerodynamics section.

**Capt. David B. Young,** USN (Ret.) has been appointed Consultant-Technical Developments for General Electric Company's Special Defense Projects Dept.

**E. M. Deckman** recently was appointed commercial sales manager of aircraft engines, Allison Division of GM.

**C. L. Peterson** has been appointed vice president and general manager of Brown Instruments Division of Minneapolis-Honeywell Regulator Co.

**J. E. Sullivan** was named manager of the Washington, D. C., offices of Lear, Inc. He was formerly civilian chief of BuAer's Airborne Equipment Division.

**Darius R. Barber** has been appointed controller of Brush Electronics Co.

**Leonard S. Wiener** has been promoted to chief rocket-design engineer of the Propeller Division of Curtiss-Wright Corp. **Jack H. Sheets** was upped to works manager. **Gordon W. MacKinney** has been named assistant to the general manager of the Propeller Division, and **Robert J. McMinn** was named manager, Contract and Order Dept.

**G. I. Sunstrom** was appointed assistant general manager of the Metals Processing Division of Curtiss-Wright; **Malvin Isaacson** was named general sales manager, and **John G. Rombough** was named Industrial Relations manager of the division.

**John B. (Jack) Gates** has been named manager of the Bell plant of Thompson Products, Inc. He succeeds **Stanley C. Pace** who has been transferred to manager of Thompson's Jet Division.

**William H. Oswald, Jr.,** was appointed Aircraft Sales manager for L. B. Smith Aircraft Corp.

**L. E. Tollefson** has been named Washington representative of Douglas Aircraft.

**Kevin P. Moore** recently was appointed aviation sales engineer for the central states for AC Spark Plug Division of GM.

**H. B. Horne, Jr.** was named assistant to Wesley R. Frysztacki, vice president of Piasecki Helicopter Corp.

**W. H. D. Hanchet** has been appointed Contracts and Service manager of Doman-Fleet Helicopters, Ltd.

**John H. Quinn, Jr.** has joined TEMCO Aircraft as chief of technical services, a new position in TEMCO's engineering Dept.

**Peter H. Stanton** recently was elected vice president and treasurer of Topps Industries, Inc.

**Paul L. Van de Velde** was made manager of operations of Airwork Atlantic, Ltd., at New York International Airport.

## COMPANIES

**Fairchild Engine and Airplane Corp.** has set up a Scientific Advisory Board for the Fairchild Guided Missiles Div. Members of the board are **Dr. Eric A. Walker,** dean of the College of Engineering, Pennsylvania State University; **Dr. Robert F. Rinehart,** professor of mathematics, Pace Institute of Technology; **Dr. Walter E. Albertson,** professor of physics, Naval War College; and **Dr. Richard M. Emberson,** assistant to the president, Associated Universities, Inc.

**Weston Electrical Instrument Corp.** has received a $4,316,000 notice of award from the Air Material Command for 9,090 course indicator aircraft instruments, a part of the instrument landing system.

**British Overseas Airways Corporation** has contracted with RCA for installation of RCA's weather-detection radar equipment on BOAC's new DC-7 fleet.

**National Airlines, Inc.** is purchasing six new Convair Model 440 *Metropolitans* from Convair Division of General Dynamics. **Swissair** has ordered eight new 440's.

## HONORS

**Jerome Lederer,** director of Flight Safety Foundation, has been elected a national vice president of the Air Mail Pioneers, an organization whose membership is limited to employes of the Air Mail Service prior to August 31, 1927, when this function was taken over by the airlines.

**Dr. William R. Hawthorne** was appointed to distinguished new faculty post of Jerome Clarke Hunsaker Professor of Aeronautical Engineering at MIT for current academic year. Dr. Hawthorne is on leave from Cambridge University, England.

**Independent Military Air Transport Association** has been given The Award of Honor by the National Safety Council.

## AERO CALENDAR

Oct. 31-Nov. 1—East Coast Conference on Aeronautical and Navigational Electronics, IRE, Baltimore, Md.

Oct. 31-Nov. 2—SAE transportation meeting, St. Louis, Mo.

Nov. 1-3—Air Transport Association's Air Traffic Conference, San Francisco.

Nov. 2-3—Transport Hydraulics Conference, sponsored by Vickers, Inc., Detroit, Mich.

Nov. 8-10—National Aviation Trades Association annual convention, Hotel Westward Ho, Phoenix, Arizona.

Nov. 28-30—Instrumentation Conference and Exhibit, sponsored by IRE, Atlanta Biltmore Hotel Atlanta, Ga.

NOVEMBER, 1955

# Skyways

**The Magazine of Flight Operations**

*COVER: Cessna 172*

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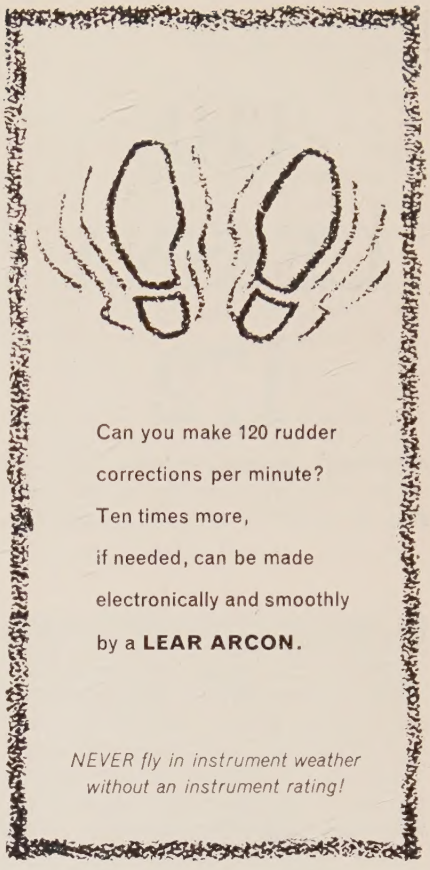
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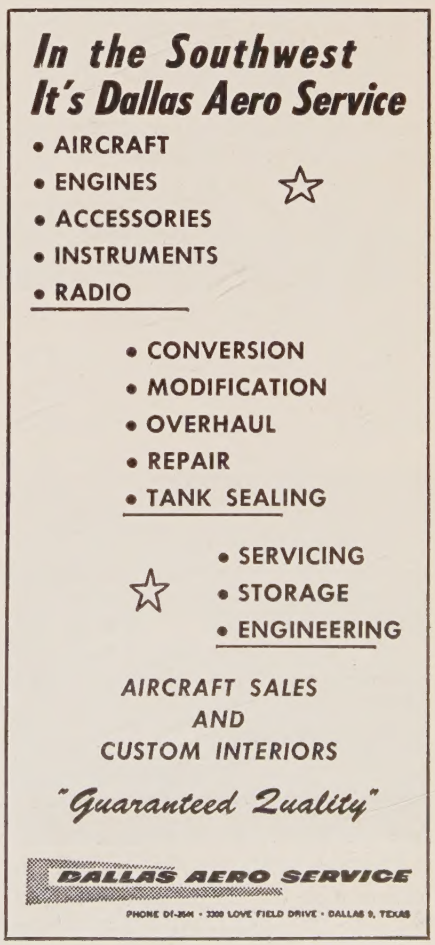
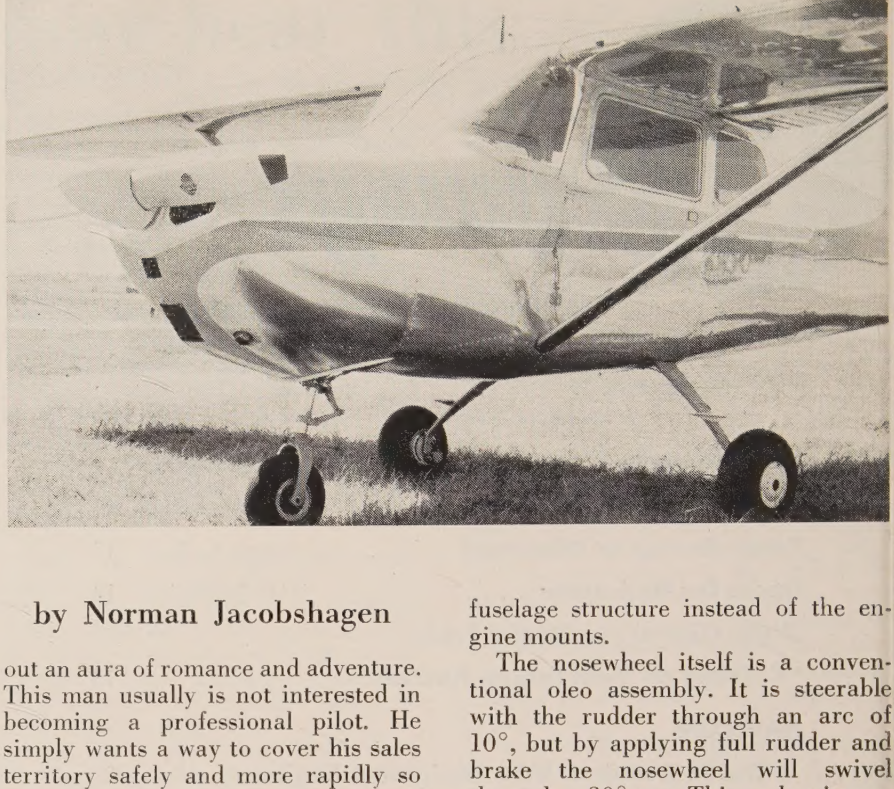


pilot's report

# THE CESSNA 172



**NOSEWHEEL** *employs conventional oleo assembly while spring leaf is used for main gear. Nosewheel is steerable through 10°*

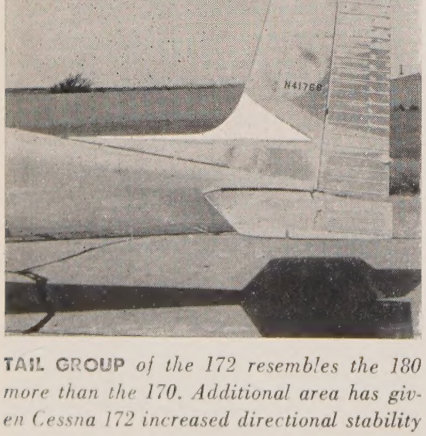
## by Norman Jacobshagen

Cessna has just announced a new tricycle-geared Model 172, claimed to be one of the easiest and safest airplanes to fly. If this sounds like braggadocio, Cessna officials hasten to point out there'll be safer and better airplanes in the future, but as of the moment they'll stick with their original statement.

This approach to making sales points out an interesting change in the philosophy of flying airplanes that has occurred over the past 10 to 15 years. Before the war, the number of pilots was small and they liked to think of themselves as belonging to an elite band of derring-do supermen.

But progress, as it has a way of doing, progressed. It was discovered that it didn't take a superman to fly. Thousands of the kids-next-door became Air Force pilots, and thousands more learned to fly on the GI Bill. Manufacturers made airplanes easier and safer to operate, and businessmen began considering the airplane as a business tool.

For the most part, the mystery of flight has been overcome. It is transportation for the average man without an aura of romance and adventure. This man usually is not interested in becoming a professional pilot. He simply wants a way to cover his sales territory safely and more rapidly so he can spend more time at home with his family. He wants transportation that will carry him to more business and get him there ahead of his competition.



**TAIL GROUP** *of the 172 resembles the 180 more than the 170. Additional area has given Cessna 172 increased directional stability*

At the same time, there are a great many businessmen who have never thought of flying their own planes, but who perhaps would, were they to realize the ease of flying and the new business it could bring in. These businessmen make up the market Cessna is endeavoring to tap. And the 172 is a firm step in that direction.

Inevitably, the Model 172 is going to be referred to as "just a 170 with a tricycle gear." The resemblance between the two airplanes is mostly superficial.

While it can be a relatively simple matter to stick a nosewheel on a conventional-geared airplane, it brings up a new set of problems. For example, there's the matter of weight and balance. Some tricycle gears have a nasty tendency to nose up when you attempt to turn downwind with a good breeze blowing. Cessna chose to go about developing a tricycle-gear plane the slow hard way. They took their time and came up with a well-engineered and satisfactory product. The years of engineering and the several models that were built and discarded have paid off in a fine easy-to-fly airplane.

But let's start at the nose and see what we have in the 172. From the firewall forward, the 172 is identical to the 170—the same engine mounts, the same prop and the same dependable 145-hp Continental. Unlike some aircraft, the nosewheel is tied into the fuselage structure instead of the engine mounts.

The nosewheel itself is a conventional oleo assembly. It is steerable with the rudder through an arc of 10°, but by applying full rudder and brake the nosewheel will swivel through a 30° arc. This makes it possible to turn the airplane in virtually its own width . . . just about as short as with conventional gear. This is an important asset when maneuvering in crowded quarters.

The fuselage appears to be similar or the same as 170. Box structure, however, that supported the original conventional gear has been moved back from a position in line with the front door post to a position approximately in line with rear door post.

Here again the new engineering shows up. This box structure, although similar to the one found in the 170, is lighter but just as strong as the original. This saving is weight, coupled with the lack of need for a tail wheel assembly and other weight-saving engineering has resulted in an airplane whose empty weight is only 12 pounds more than the 170. This is a small penalty to pay for the easy ground handling and safety that comes with the tricycle gear.

The 172's tail configuration is entirely different from that of the 170. It is larger in area, both in the vertical and horizontal stabilizers. Straight lines and square tips make it look very much like the 180 empennage.

When you get ready to enter the cabin, you'll find the step is placed, position and height-wise, for easy entry. Even lady passengers should find it an easy matter to climb in and sit down without acrobatics or the need for slacks.

If you've been flying a 170, you'll feel right at home in the 172. The cabin appears to be the same size and

ffers the same roomy comfort for our adults. But the dark browns and rays in interior decor have given ay to a bright blue and white à la 955-56 automobiles. The whole effect brighter, more cheerful and very ttractive. The headliner and seat trim washable plastic that should be easy keep clean and new looking for a ng time.

The instrument panel has been hanged slightly but anyone who has own a 170 will find no difficulty in nding the instruments and switches lmost immediately. The important hange (although a small one) has een in relocating the starter button. t formerly was located on the far ght side of the panel. It couldn't be eached without getting tangled up h the dual wheel. And to make matrs worse you had to make like a retzel to reach over and operate the hrottle with your left hand. It was a razy, mixed up operation.

I don't know who decided to put he starter on the left side of the panel here it belongs, but if the factory oesn't give him a special commendaon, future owners of 172's certainly ill. Now you can easily and comrtably pull the starter with your ft hand and operate the throttle ith the right in a normal fashion.

The gas selector valve and trim-tab heel are in the same old place on he floor between the seats . . . easy see and easy to operate. As Bill orris, genial Regional Sales Manger who was assigned to show me the rplane, so aptly put it, "There's no heckout in this airplane. Just climb , start the engine and drive it way." It's just about that easy.

Visibility, of course, is terrific. The ew over the nose is better than most tomobiles and the steerable nosheel works smoothly with minimum rces. As the 172 was still pretty uch under wraps, it had been parked hind the experimental hangar out f the sight of the curious. To get it to e runway it was necessary to taxi er some extremely rough ground, uch rougher than you'd normally pect to encounter in anything but n emergency. It made a wonderful troduction to the ground stability d riding qualities of this new gear. here was considerable pitching as ere is on most short wheel base vecles, but the spring action of the ain gear and the oleo action of the sewheel were good and the airplane d a good solid feel.

Once on the field, Norris suggested e make some high-speed taxi runs. his we did with the wind blowing a arp 20 to 25 miles from the south—d that experience is hard to deribe in words. It has to be done to e appreciated. Downwind, upwind, crosswind . . . it was a smooth ride with complete stability and control at all times. The only unusual indication that we were doing things you normally wouldn't do in an airplane was during crosswind runs on a macadam surface. The airplane gets light and takes weight off the rear wheels. The crosswind puts a load on the tires and they screech like a hot-rodder going flat-out around a corner. But the famed Cessna landing gear stretches out and holds the airplane solid. I can only say that anyone who isn't sold after trying this for himself is a complete and unreformed reactionary.

Your first reaction as you start rolling down the runway for take-off is the ease of holding the airplane straight. There is torque, because I made one take-off without using rudder and the nose swung slowly to the left during the take-off roll. But with the tricycle gear, holding the plane straight down the runway is so easy that the effort is almost unnoticeable.

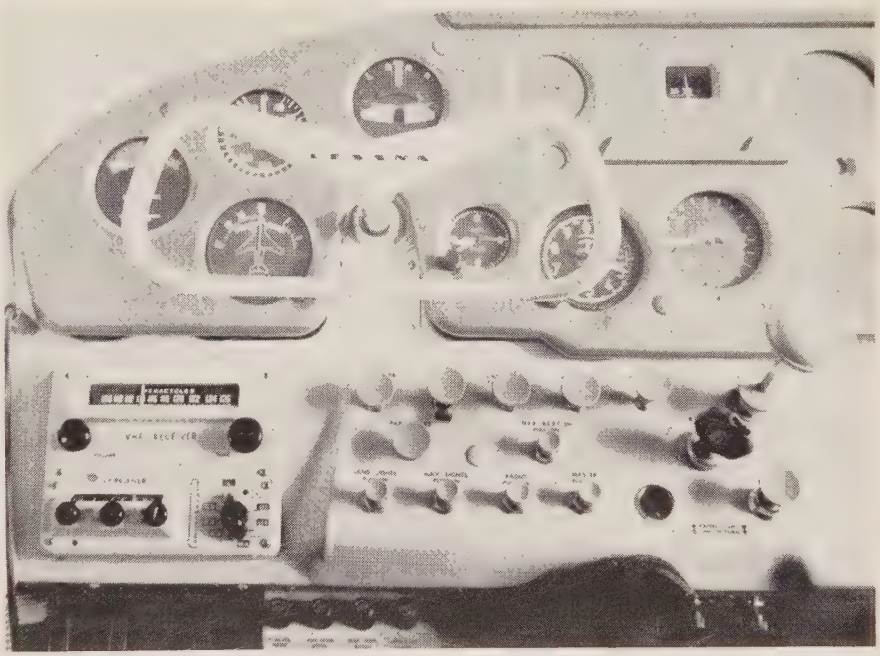
The second impression is of the early effectiveness of the elevators. At unusually low ground speed, up elevators will raise the nose. This can be extremely important when operating in mud, high weeds, snow or soft ground, for you've got to get the nosewheel off the ground at fairly low speeds in order to get up enough speed for take-off.

In normal take-off with this airplane it is a very simple matter to let it roll until take-off speed is reached, pull back the wheel and take to the air. The procedure is so simple that a beginning student could be making good take-offs within the hour.

In discussing the 172's performance, Norris reported that the nosewheel penalized cruising speed only 3 to 5 mph. So immediately after take-off we skimmed the trees for a cruising-speed check. This was done by taking the stop-watch times in four directions, using the mile section lines as markers. The outside temperature was 95°, the altimeter showed us to be 1500 feet above sea level, the wind was blowing 20 to 25 mph and the air was as rough as a county side road. Under these circumstances my readings were not the most accurate. But even against such odds, plus my inexperience with the airplane, we arrived at a cruise of 118 mph, indicating that the Cessna Company, as usual, gives published performance on the conservative side.

After the speed runs, we climbed to 4,000 feet. Here again rough air made it difficult to hold the best airspeed for maximum climb. With the two of us and full tanks of gas that speed was between 60 and 65 mph. Due to the rough air, the rate-of-climb indicator bobbed around a good deal but I'd say 800 fpm was a good average. This again indicates to me that Cessna's figures are conservative and can be equalled or bettered by even a novice pilot.

At 4,000 feet I tried a few stalls. Elevator pressure on the 172 is quite high, especially if the trim tab is not rolled back. This alone would be considerable warning against approach-



**INSTRUMENT PANEL** *of the new tricycle-gear 172 is similar to that of the Model 170. Main improvement is the relocation of the starter, now more accessible to the pilot*

**LUGGAGE COMPARTMENT** *has an allowable load of 120 pounds. Powered by 145-hp Continental engine, the 172 cruises at 120 mph-plus and has range of over four hours*

ing the stalling speed for it took a concentrated effort and real physical strength to hold the nose up. It would seem to me to be difficult to stall the airplane without knowing it . . . even in moments of stress.

Once you get it stalled, there is some shaking and a gentle bobbing of the nose with little or no tendency to roll off. A little rudder is quite sufficient to hold it straight. Or, if you prefer, keep your feet on the floor and hold the plane straight with the ailerons. The 172 seems to have aileron throughout the stall.

Don't take this as gospel truth until you've had more opportunity to play around with this aspect of the 172's flight characteristics. I've found airplanes that *seemed* to have aileron control through a stall . . . and did for nine straight times. But on the 10th time, with everything just right, they would whip into a spin when you tried to roll out of a wing-down position. In any case, the 172 seems to be a well-behaved airplane in a stall. One more factor in its favor as a safe and easy airplane to fly.

During our flight time, the good riding qualities of the 172 were quite noticeable. Even in the rough air it had a good solid feeling. Directional stability also seemed good . . . an improvement over the 170. The whole feel of the airplane is more like that of the 180. This may be due, in part, to the larger area of the vertical and horizontal stabilizers. It's possible that the nosewheel plays a small part.

With hands and feet off the controls the airplane seemed to do its utmost to retain its original heading. When gusts would put a wing down, it would turn slightly but invariably return to an even keel instead of continuing or steepening the bank. At the end of four or five minutes of hands-off flying, we weren't more than 15° off our original heading.

Flying with aileron alone also has been improved over that of the 170. Rapid use of the aileron, of course, causes considerable yaw, but with reasonably smooth use, you can make good turns with little or no yaw. This is important because it makes flying cross-country less tiring. Aircraft that need constant attention on the rudder restrict you to one sitting position which is cramping and puts muscle-tension on the legs. With the nice aileron response of 172, you can fly long trips in real comfort and relaxation.

All this flying had taken the better part of an hour so we headed back to shoot some landings. Cessna's field is located right next to a B-47 training field. Four or five of the brutes were keeping a steady circle going as they shot touch-and-go landings. This made it necessary to sneak in under the traffic pattern. With this, a strange airplane, rough air and a crosswind on the runway, I really goofed up the approach. I was just about to apologize to Norris for a bit of lousy flying when I suddenly discovered the airplane was landed and rolling.

I should have quit while I was ahead, but this was too much fun. We shot several more landings, flaps up and flaps down, but they were all the same. I honestly believe it is almost impossible to make a bad landing in this airplane. For my money it's the airplane for the businessman-pilot, the flying salesman who makes his airplane a vital tool in his business.

After the flight, Bob Chatley, Cessna's Director of Sales Promotion and Advertising, asked me how I liked it. I immediately offered to bet that within a year the 172's would make up the great majority of their small-plane production because practically everyone would want the tricycle gear. Chatley smiled at my enthusiasm, but explained that Cessna still felt there was a place for the conventional gear. He told of a rancher who lands his 170 in spots that he (Chatley) wouldn't want to land a helicopter. The company opines that this kind of use is not for the tricycle gear and for this reason they'll be turning out 170's for a long time.

Cessna should know, but I'll sti wager that 172 will be one of the mo popular airplanes of 1956.

**Specifications**

*Engine:* Continental O-300-A (6 cyl.) ..... 145 h
*Top Speed* ..... over 135 mp
*Cruising Speed* ..... over 120 mp
*Cruising Range* ..... 4½ hou
*Rate of Climb (Sea Level)* 660 fp
*Service Ceiling* ..... 14,300
*Gross Weight* ..... 2200 lb
*Empty Weight* ..... 1260 lb
*Luggage Compartment Allowable Load* ..... 120 lb
*Fuel Capacity* ..... 42 U.S. ga
Span ..... 36
*Length* ..... 25
*Height* ..... 8 ft 6i
*Wing Area* ..... 175 sq
*Wing Loading (per sq ft)* .. 12.6 lb
*Power Loading (per hp)* ... 15.2 lb

**Standard Equipment**

Airspeed Indicator
Altimeter
Compass
Stall-Warning Indicator
Shock-Mounted Instrument Panel
Hydraulic, Toe-Operated Brakes
Steerable Nosewheel
"Para-Lift" Wing Flaps
Parking Brake
Tie-Down Rings
Engine Mufflers (Stainless Steel)
Key-Operated Door Lock
Engine Shielding
All-Metal Propeller
Propeller Spinner
Gravity Fuel System
Recording Tachometer
Mixture Control With Safety Lock
Oil Pressure Gauge
Oil Temperature Gauge
Carburetor Heater
Carburetor Air Filter
Direct-Reading Fuel Gauges In Cab
Dual Magnetos
Generator
12-Volt Battery
Instrument Panel Lights (Adj.)
Dome Light
Navigation Lights
Map Light
Landing Light Wiring and Bracket
Four-Position Fuel Selector Valve
Key-Operated Ignition
Starter
Ammeter
Cigarette Lighter
Map Compartment
Individual Ash Trays
Cabin Heater
Cabin Air Vents
Suit Hanger in Cabin
Attachments and Brackets for Sun Visor and Safety Shoulder Harne
Full Foam-Rubber Seat Cushions
Adjustable Seats (Front & Rear)
Attach. for Cargo Rings & Harness
Price ..... $8,7

# ENGINE MALFUNCTION

by Edward T. Martin

*Flight Instructor, Pan American World Airways*

The dependability of the modern reciprocating aircraft engine is a quality which is quite remarkable considering the engine weight-to-power ratios, the high powers consistently drawn from the powerplants, and the long operating time between overhauls. Obviously, a continuing maintenance and inspection program contributes toward this increasing dependability and is necessary to profitable and dependable airline operations and efficient business-aircraft operations. The dependability of the aircraft engines, however, is most important to the safety of crew and passengers flying in the airplane, since their lives may depend on the continued normal operation of all engines during the entire stage of the flight. The flight and performance characteristics of most all multi-engined aircraft and in particular the T-Category aircraft, are sufficient to provide controllability and performance for all routine conditions of flight at and beyond the critical engine failure speed $V_1$ on take-off, assuming an engine failure. The crew must, of course, be competent in handling the aircraft properly under emergency conditions of engine failure, realizing also that performance cannot be expected of the aircraft in excess of the engine-out performance limits considering flight plan, terrain clearance, alternate airports, adverse weather, etc. In any event, where engine failure is experienced the safety of the flight will depend upon the combined skill and judgement of the crew in having made advance allowances for such emergencies and in properly evaluating and handling the emergency if it arises. The present-day dependability of aircraft engines is such that pilots infrequently experience engine failures and as a consequence some may tend to place more confidence than is warranted in the continued operation of the powerplants. As a result, they may also tend to become somewhat lax in their engine checkout procedures prior to take-off, and engine monitoring during flight. Further, either through lack of experience, training, or alertness, they may possibly neither determine the existence of, nor adequately interpret the indications of either minor or serious engine malfunctions. The correct and speedy evaluation of the operating condition of the engine coupled with decisive action may be as important as skill in handling the airplane under engine-out conditions.

Delay in handling or misinterpretation of the symptoms of engine malfunction might lead to trouble of more serious nature which could exceed the limits of control available to the crew.

To attempt here to set forth hard and fast rules for the evaluation of engine malfunctions covering all conditions would be impractical since there are many types of engines and each malfunction may contain one or more elements in varying degree. This job is for the skilled mechanic who has the knowledge, tools and time to evaluate and repair the particular engine in question. The use of an engine analyzer, of course, would enhance the evaluation. However, what is desired here is more of a general outline of evaluation useful to the workaday pilot who may not have an engine analyzer at hand or even the minimum in fire detection and warning devices. What the pilot is interested in then is basically the soundness of his engine runup and checkout technique and in-flight evaluation of engine operation.

### Engine Runup

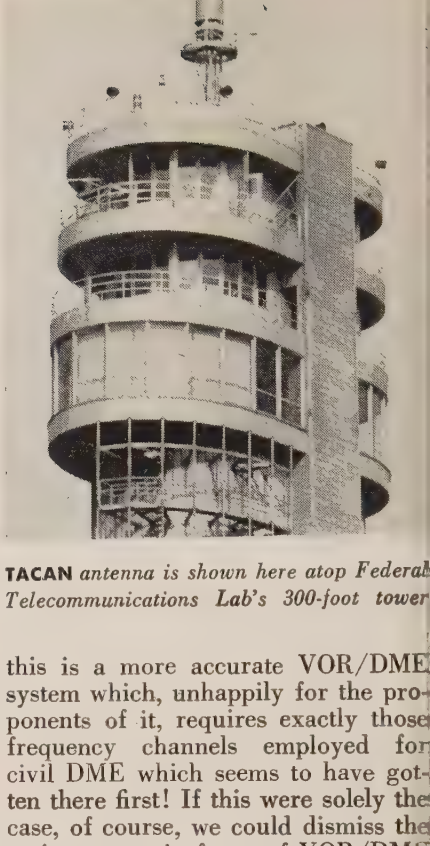
Needless to say, the engine runup is the most important engine checkout the pilot can make prior to his flight. Prior to the engine runup, however, it is always good practice to have made a circle tour of the aircraft exterior with particular attention to the engines for signs of oil leaks around the nose sections, cowl-flap areas, accessory sections, wheel-well areas, and oil coolers. Any abnormal collection of oil at the above mentioned areas or on the landing gear, underwing area, under-belly area, or even on the ground under the aircraft would suggest excessive leakage from the previous flight. The engine in question should be washed down and then run with cowls removed to determine origin of the leakage. Appropriate repairs should then be effected. A thorough engine checkout will preclude to a great degree the remote chance of trouble on the take-off which usually is the most critical segment of the flight. Obviously, governing, feathering, generator load, carburetor heat, temperatures and pressures should all be properly checked out. Next in line is the magneto check. Take-off definitely should not be attempted when an engine does not check out within limits on the ignition check, *i.e.*, where greater than allowable RPM and BMEP drops exist. This check should be done at the highest recommended manifold pressure for ignition check; usually at field barometric pressure with mixtures rich. Also at this point, the RPM should be noted for power check on the prop load curve. Normally, a specified RPM should be obtained at field barometric manifold pressure in zero wind. The mag check should then be performed in a manner which will definitely indicate any ignition malfunction, preferably where the pilot checking the mags calls out "*On Left, On Both, On Right, On Both*" for each engine checked, and watches for RPM and BMEP drop while checking engines on the co-pilot's side, and watches engines on his own side for engine roughness while the copilot checks for RPM and BMEP drop. The copilot, of course, would watch the engines being checked on his side for roughness while the pilot checked for RPM and BMEP drop. While visually checking the engines for roughness, the pilot and copilot should look over the engines for signs of smoke or oil leaks which could indicate malfunction. In this manner an adequate cross-check of RPM and BMEP drop, if any, will have been made coupled with a visual check of the engine. Enough time interval always should be allowed while checking each mag and the "*On Both*" position to establish a through check.

(*Continued on page* 35)

# TACAN— DEVICE or DILEMMA?

by Joseph G. Bush

*Executive Pilot and Electronics Specialist*



**TACAN** *antenna is shown here atop Federal Telecommunications Lab's 300-foot tower*

How often must one draw the fine line of distinction between natural resistance to change and sober objection to premature discard of tried and proven values? This is the problem that must be faced by the working air-transportation industry in deciding for or against TACON as opposed to the operational VOR/DME system of today.

When all the technicians have ceased their involved debate as to the technical virtues of each system, it will fall to the working pilot to decide for himself whether TACAN offers sufficient advantage now and in the future to warrant public demand for any change. Economics of the situation are a considerable factor, but pilots—airline, private, and corporation—are a notably selfish group when it comes to grasping at any device that is a better form of insurance of their own necks.

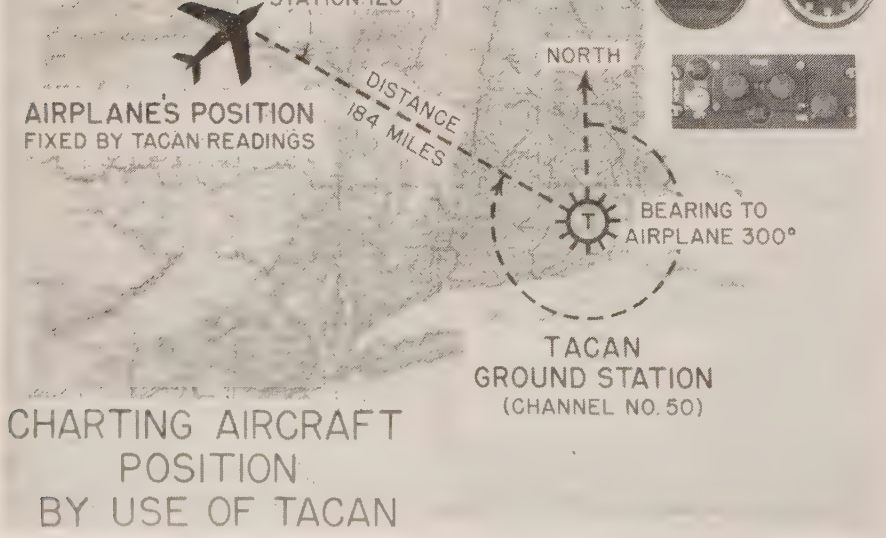
No matter how bungled the approach was to introducing TACAN as a "must" substitute for VOR/DME, the pilot wants to know one thing: is it sufficiently better to warrant an investment for increased safety sake if not for increased ease of navigation? This was the question uppermost in this pilot's mind as we climbed aboard the IT&T DC-3 at Teterboro for the first public showing of TACAN.

The first strong impression is that, insofar as the pilot-user is concerned, this is a more accurate VOR/DME system which, unhappily for the proponents of it, requires exactly those frequency channels employed for civil DME which seems to have gotten there first! If this were solely the case, of course, we could dismiss the entire matter in favor of VOR/DME which is an acknowledged state of continual improvement anyway.

Again unhappily, it is not so simple because even with the expected improvement of the les-than-perfect VOR/DME combination, there are ample indications that TACAN is capable of always being ahead of VOR/DME in several ways: accuracy, simplicity, siting, facility of airborne equipment and installation, etc. Cost is also claimed to be significantly less, but this we will regard with a jaundiced eye until the first year's civil production line set is on the market at a fixed price.

To review briefly the technical description of the system as it has been publicized, TACAN is an integrated bearing and distance radio navigation aid operating in the 962-1213 megacycle range, and is capable of providing information up to a line-of-sight range of 200 miles. Cockpit instrumentation is essentially the same as for VOR/DME. A pilot would find no problems in changing from one system to the other.

The system is claimed to provide a bearing accuracy of better than $\pm 1°$ combined error as against the accepted figure for VOR of $\pm 5°$. Distance accuracy is claimed in the order of $\pm 600$ feet, plus .15% of the distance measured or, in round figures, $\frac{3}{10}$ of a mile at distances up to 20 miles. On the demonstration flight, it was necessary to fly slightly offside of the checkpoints, accurately

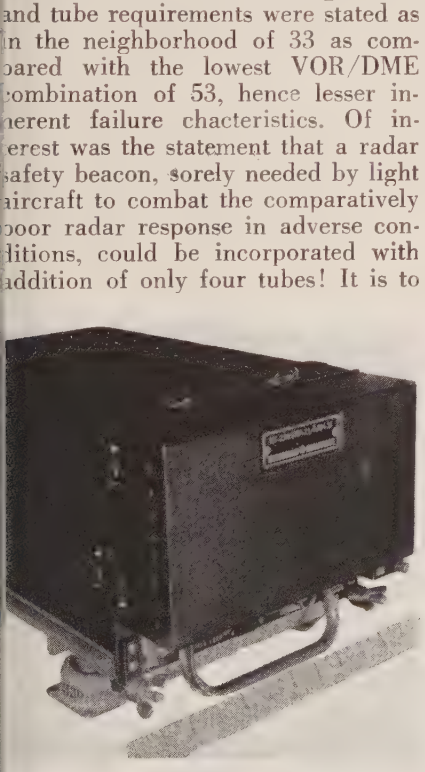



CHARTING AIRCRAFT POSITION BY USE OF TACAN

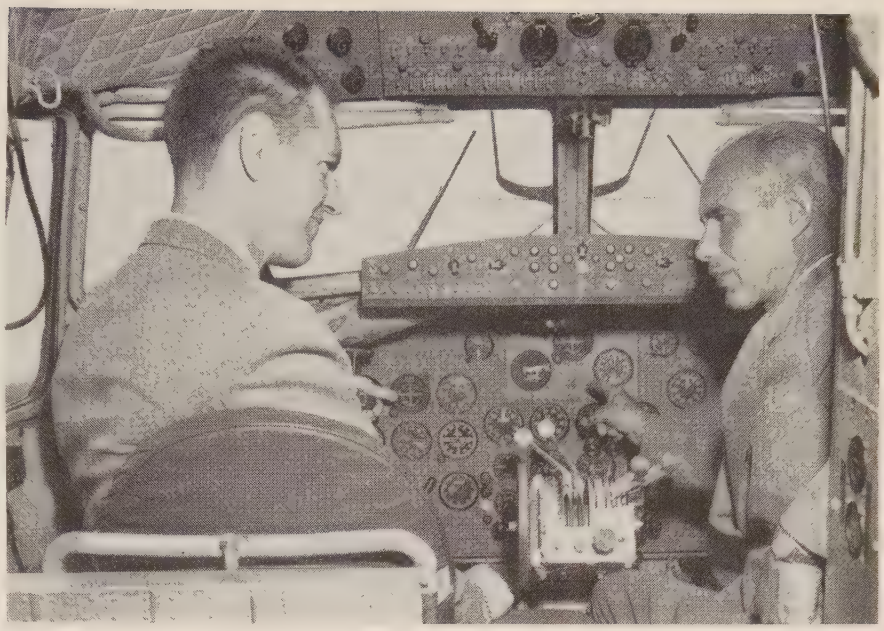
measured and labeled on the chart provided, so that cabin passengers could observe them and compare the cabin instrument readings with the chart figures. The obvious discrepancy required interpolation and this was done by IT&T experts who, as engineers and aviation personnel, did an equally excellent job as salesmen.

Because we are going to state unqualifiedly that there is every indication that TACAN merits further attention and development as a superior system to VOR/DME, let's consider some of its technical aspects and its shortcomings. We were shown two types of airborne equipments and were told of three. The two we saw were the military version which mounts in a one ATR rack, weighs between 56 and 65 lbs, uses 76 tubes (one expert spoke of 74 tubes) and uses 500 watts of power, and the "private flyer" version, the so-called "shoebox" (size 15 EE!) which was a "research" version only. We would prefer to call it "the IT&T answer to Messrs Quimby, Riddle and Karant," or a hasty response to the stinging slap administered by them following the premature advertisement of some months back of a private-flyer TACAN whose status of existence was protected by "security."

With reference to this smaller version, on which no production promise was even generalized, the admitted accuracy was "considerably less" in the interest of cost and weight/size, and tube requirements were stated as in the neighborhood of 33 as compared with the lowest VOR/DME combination of 53, hence lesser inherent failure chacteristics. Of interest was the statement that a radar safety beacon, sorely needed by light aircraft to combat the comparatively poor radar response in adverse conditions, could be incorporated with addition of only four tubes! It is to be hoped that research and development of this model will not cease, if and when IT&T concludes thay have won the fight against VOR/DME.



**AIRBORNE UNIT** *combines the multi-channel receiver and transmitter with video circuits operating distance, bearing gauges*



**TACAN INDICATORS** *mounted on instrument panel are pointed out by E. DeFaymoreau (right), FTL's associate laboratory director. The indicators give distance and bearing of aircraft to fixed ground station. Shown with Mr. DeFaymoreau is Capt. A. Sweezey*

A third version of the airborne equipment was mentioned, a civil version not unlike the military which has been on the production lines for two years. The question as to meeting ARINC specifications at a weight and price figure, elicited the response that said unit would be at ½ ATR rack size, would emphasize reliability rather than miniaturization of components, and would employ the same components grouping system of the military version, facilitating maintenance. Price was estimated (hold on to your seats!) as "around $2,000"! We have never hoped more that we are wrong than when we now say that we will buy the cigars if the complete TACAN airborne equipment, built to ARINC specs, arrives in the cockpit of tomorrow's airplanes at a figure less than two to five times that amazing quotation. We would consider it an excellent investment if, one year from the time the professional civil version goes on the market, we can buy this completely integrated, more accurate and versatile equipment for under $10,000.

To realize how amazing such a promised price would be, recollect that the cheapest DME alone costs upwards of $5,000 and the combination of DME with a good quality VOR can easily double that price—then add the statement of Mr. Henri Busignies, executive vice president and engineer/inventor to whom most credit is given for this development, that IT&T is giving some thought to the idea of reimbursing current purchasers of DME for their loss when replacing with TACAN! To accomplish this, it might be necessary to exchange the equipments gratis with a substantial bonus to the consumer to boot! So, maybe we can dismiss the estimated target price and be prepared to be agreeably pleased if TACAN will soon be available (*and usable*) at a comparable figure to VOR/DME combination when the latter has attained an age of reasonable amortization.

It is admitted that TACAN, as yet, has arrived at no basis for assuring its users in the navigable airspace of the accuracy standards of any other user's airborne receiver, something on which safe separation depends and which is a knotty problem now with VOR airways and holding procedures. Also, no provision is contemplated for employment of the same frequency channels for voice communication. Unlike the VOR, reliance on the carrying of additional voice communications equipment, is admitted, which could be considered a point in refutation of the weight/size argument. Aside from the safety aspect, this omission helps to point up the improbability of any serious development of a unit designed to supply the personally flown single-engine and light-twin business planes with an all-in-one package.

There is no question but that TACAN is capable of accommodating off-course computers now employing VOR/DME as their receiving components, hence no disadvantage is expected here. Similarly, it is obvi-

(*Continued on page* 39)

**DECCA SYSTEM** *has been used as navigation aid for 'copter operations for several years, although lightweight Flight Log only recently was developed. Decca's accurate track-keeping aids in avoidance of obstructions in vicinity of 'copter routes flown*

# Decca For Helicopter Navigation

by J. H. Overholser

*Bendix Aviation, Pacific Div.*

New Decca chains—to be built in Sweden, Scotland, France and India—highlight the rapid growth of the Decca System and its wide acceptance as an air-navigation aid. In a matter of eight years the system has spread from a relatively small area in southeast England to the greater part of northwest Europe. Over 2600 naval and merchant ships of all classes, including large ocean liners, coasters, fishing vessels, cable-laying ships, survey and salvage vessels, now are fitted with the Decca Navigator, and airliners, charter airplanes and helicopters in increasing numbers are using the Flight Log, the navigational device which gives pictorial presentation, as a primary navigational aid in the Decca coverage area. The lightweight air equipment only recently has been developed for the whirlybirds.

Since the helicopter normally operates at altitudes of between 300 and 2,000 feet, it is necessary in high-density areas to rely mainly on lateral spacing of aircraft tracks to secure safe separation. As a result, accurate track-keeping by the pilot is a necessity reflected in the stringent accuracy requirements relative to the enroute navigational aid.

Quite apart from the problem of Air Traffic Control, since the helicopter flies at low altitude, possibly in poor horizontal visibility and under low cloud base conditions, accurate track-keeping is also essential from the standpoint of avoiding obstructions or high ground in the vicinity of the route being flown. Therefore, accuracy and solid coverage over a wide area at low altitude are important requirements of any helicopter navigation-aid system.

Decca, in one form or another, has been used with helicopters since 1948. By the end of 1954 one airline had accumulated almost 800 hours of operation with the system, and during this period, Decca made possible the continued operation of airline service under weather conditions in which it would not otherwise have been possible. The Flight Log is used to ensure accurate track-keeping and determination of ETA's at appropriate check points or destinations.

In trials Decca has been used as a helicopter let-down aid, and these tests have proved highly promising. The technique employed is to select a suitable lattice line passing through the desired landing area and, by means of the Flight Log and decometers, position the aircraft for an approach along this line. A left/right homing procedure is than followed using the appropriate decometer as a deviation indicator. By the use of a precomputed approach chart which shows what the helicopter's height above the ground should be as it intersects the lattice lines, a step-down approach is carried out.

Decca truly can be termed an ideal helicopter aid. It is accurate; the range of the system is unaffected by altitude, right down to the ground; due to the long wavelengths employed (about 3,000 meters), the system operates when flying low behind hills or making let-downs among high buildings; and, lastly, the information given to the pilot is easy to interpret with use of the Flight Log.

A single four-station Decca chain covers an area of approximately 100,000 square miles at the high-accuracy level required by helicopters, and everywhere in that area, down to ground level, the continuous position-fixing service is available without interruption.

Bendix-Decca Navigator system provides a position fix by deriving arbitrary index numbers of an appropriate pair of ordinates which intersect at the point of position. With this information position can be automatically and instantaneously displayed on a chart through the medium of a moving ink stylus or it may be displayed on meters for

nanual transfer to an overprinted hart.

These ordinates are hyperbolae hich belong to two different fami- es. From the foci of the families, ontinuous-wave radio transmissions f frequencies in the region of 100 c are emitted. The transmissions re made on different but harmonical- r related frequencies which, after eception, are converted to a common requency.

Along each hyperbolic ordinate or ne of position, the difference in the me of arrival of the radio waves rom the foci will be specific and onstant and, therefore, the phase ifference between radio waves will e both specific and constant. This onstancy of specific phase difference ong each line of position is used establish the particular line of posi- on in the family upon which a ehicle is situated at any instant.

In order to obtain satisfactory overage 360° around the group of ransmitting stations, a third family hyperbolae is provided between e Master Station and a third trans- itting point. Thus, there is a Mas- r Station with three other stations, nown as Slave Stations, grouped round the Master. The Slave Sta- ons are designated Red, Green, and urple and, according to the vehicle's osition around the group of stations, osition is established by employing e most suitable pair of the Red, reen and Purple families of hyper- olae. The distance between the Mas- r Station and each Slave Station usually between 60 and 100 miles.

The accuracy of measurement of ase difference is approximately 3° hich, on the base line between a ir of transmitters, is equivalent to proximately 5 yards. With in- ease of range from the transmitters, e position-line accuracy drops mewhat.

The most serious factor governing e reduction of accuracy with range the inevitable presence of sky-wave ce a certain range has been reach- . The presence of sky-wave gives se to errors due to the receiving uipment taking cognizance of the sultant phase angle between the y-wave and ground-wave, instead the phase angle of the ground- ave alone. This condition is reach- l, under the worst conditions at ght time, at something over 300 iles. For safety, 240 miles has been osen as the recommended normal aximum range of operation around e 24 hours.

Considering a pair of Decca trans- itters on a base line of 100 statute iles, the standard deviation of posi- on-line errors at the mid-section of e pattern, under the worst and best conditions are as follows:

1. *Under the worst conditions.*

"Night at all seasons" and "Winter at dusk and dawn."

| | |
|---|---|
| At 50 miles ..... | 25 yards |
| 100 miles ..... | 50 yards |
| 150 miles ..... | 100 yards |
| 200 miles ..... | 200 yards |
| 240 miles ..... | 600 yards |

2. *Under the best conditions.*

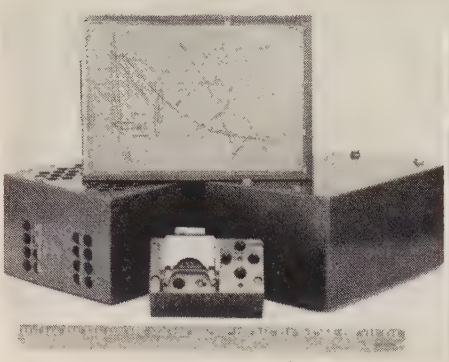
"Summer Daylight, Late Spring Daylight and Early Autumn Daylight."

| | |
|---|---|
| At 50 miles .... | under 10 yards |
| 100 miles ..... | 10 yards |
| 150 miles ..... | 17 yards |
| 200 miles ..... | 30 yards |
| 240 miles ..... | 75 yards |

A most important advance in the development of the Decca Navigator System as an aid to air navigation has been the automatic presentation to the pilot, on a special chart, of a continuous record of the position of his aircraft, so that at a glance and without any plotting whatever he can obtain all the information that Decca can give. The instrument which gives this facility is the Decca Flight Log.

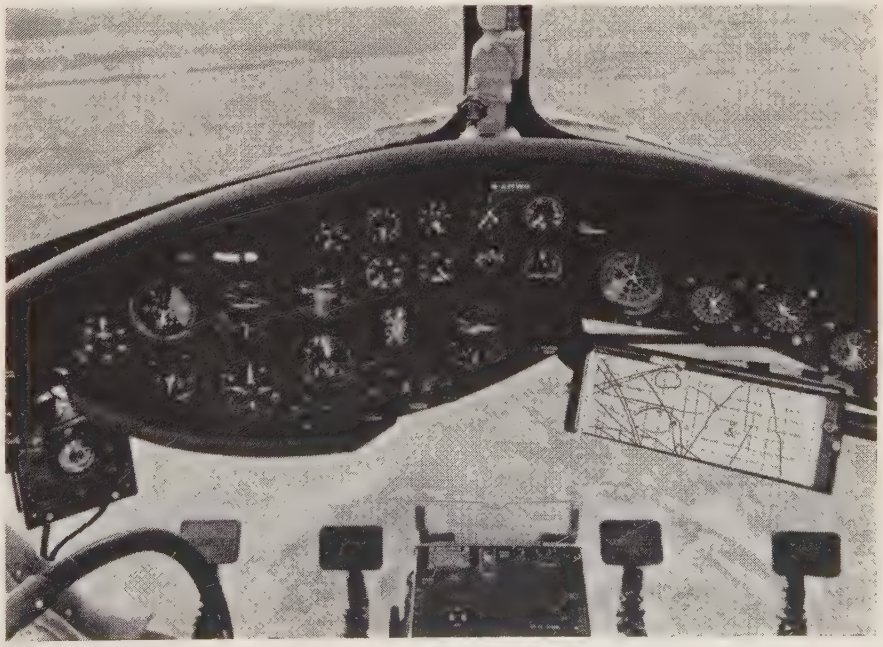
The principle of operation is that the chart itself in the simplest case shows physical features, airports, control zones and other necessary information plotted with respect to, say, the *Purple* Decometer reading as abscissa and the *Green* Decometer reading as ordinate. As the *Purple* Decometer rotates, the forces driving it are amplified by a Torque Converter Unit to give sufficient power to drive the styles across the chart in step with this Decometer, while the chart itself is moved in a similar fashion vertically relative to the pen in accordance with the dictates of the *Green* Decometer reading.

(*Continued on page* 34)



**FLIGHT LOG** *consists of display unit and its associated receiver, computer, control box*

**TYPE 01** *display head can handle 12 charts; pen records track of aircraft on the chart*

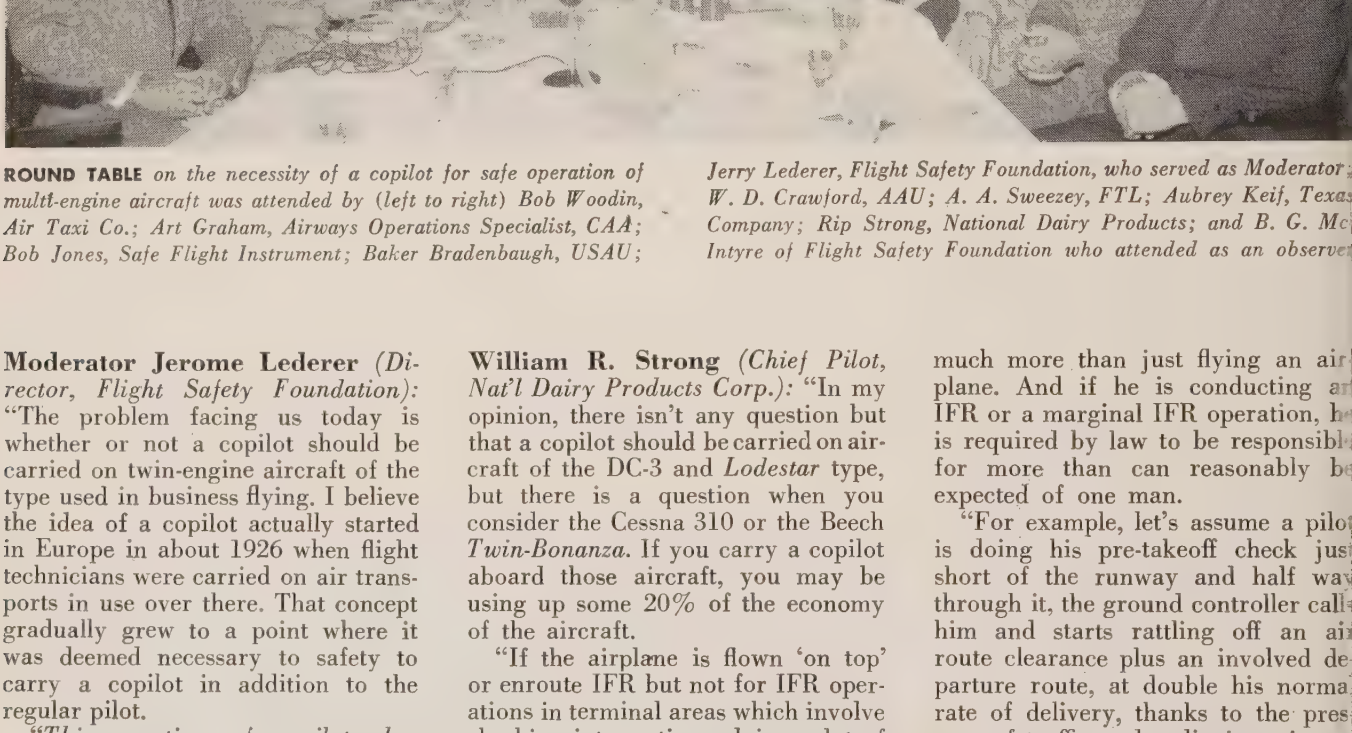


**HELICOPTER** *installation of the Decca System features the Flight Log mounted on the right side of the panel. Tests have proved Decca highly promising as a Helicopter let-down aid*

SKYWAYS
FLIGHT OPERATIONS
ROUND TABLE

*NOVEMBER 1955* *Wings Club, New York*

# "Copilots on Twin-Engine Aircraft"



**ROUND TABLE** *on the necessity of a copilot for safe operation of multi-engine aircraft was attended by (left to right) Bob Woodin, Air Taxi Co.; Art Graham, Airways Operations Specialist, CAA; Bob Jones, Safe Flight Instrument; Baker Bradenbaugh, USAU; Jerry Lederer, Flight Safety Foundation, who served as Moderator; W. D. Crawford, AAU; A. A. Sweezey, FTL; Aubrey Keif, Texas Company; Rip Strong, National Dairy Products; and B. G. McIntyre of Flight Safety Foundation who attended as an observer.*

**Moderator Jerome Lederer** *(Director, Flight Safety Foundation):* "The problem facing us today is whether or not a copilot should be carried on twin-engine aircraft of the type used in business flying. I believe the idea of a copilot actually started in Europe in about 1926 when flight technicians were carried on air transports in use over there. That concept gradually grew to a point where it was deemed necessary to safety to carry a copilot in addition to the regular pilot.

*"This question of copilots has many facets, but the basic problem is, where do you draw the line of demarkation . . . where or on what equipment is it considered unnecessary to have a copilot?*

*"Perhaps the answer to that question is a function of the complexity of the airplane: its range, its speed, especially on approach, the handling characteristics of the airplane, and the fatigue factor as it applies to the pilot. This matter of complexity also includes communications and the various things that go on outside of the airplane which may make an additional person necessary.*

*"Rip Strong, what are your ideas in this direction?"*

**William R. Strong** *(Chief Pilot, Nat'l Dairy Products Corp.):* "In my opinion, there isn't any question but that a copilot should be carried on aircraft of the DC-3 and *Lodestar* type, but there is a question when you consider the Cessna 310 or the Beech *Twin-Bonanza.* If you carry a copilot aboard those aircraft, you may be using up some 20% of the economy of the aircraft.

"If the airplane is flown 'on top' or enroute IFR but not for IFR operations in terminal areas which involve checking intersections, doing a lot of tuning, etc., then I think a single pilot without a copilot can handle the operation very well. All-weather operations requires a second man in the cockpit."

**Jerry Lederer:** *Art Graham, you are control tower man with us. What is your thinking?"*

**A. E. Graham** *(Supervisor, LaGuardia Tower, CAA):* "I agree with Rip Strong that the type of operation has more to do with it than the airplane itself. A pilot who is flying in and out of high-density terminal areas isn't just flying a machine. There are certain restrictions imposed on him, such as pre-takeoff check lists, landing check lists, etc., that make his job much more than just flying an airplane. And if he is conducting an IFR or a marginal IFR operation, he is required by law to be responsible for more than can reasonably be expected of one man.

"For example, let's assume a pilot is doing his pre-takeoff check just short of the runway and half way through it, the ground controller calls him and starts rattling off an air route clearance plus an involved departure route, at double his normal rate of delivery, thanks to the pressure of traffic and radio jamming at that moment. The pilot in this instance has to drop whatever he's doing, grab a pencil and a piece of paper and start copying the clearance so he can read it back accurately and comform with it after his takeoff. It would be bad enough if two pilots were involved and one could go right on with the takeoff check, but if there's just one pilot, he might miss an important safety item in the takeoff check."

**Jerry Lederer:** *"How would you distinguish then between a light-twin and a single-engine Bonanza?"*

**Art Graham:** "There again, it's a matter of the type of operation. It's quite conceivable that a DC-3 pilot

in a VFR operation who has nothing to do but take his time with his pre-takeoff check and then sail off into the clear blue could conduct a safe operation by himself and without hazard to himself or to others. But, under instrument conditions, even a pilot flying a single-engine airplane might need more hands, more time and more concentration on things than one person can do safely.

"Many traffic controllers either were or still are active pilots, and they are very sensitive to the problem of the pilot in the cockpit, but controllers simply haven't the time to devote special attention to these pilots who are operating with certain limitations.

"Let's say we have a pilot taking off from Runway 13 at LaGuardia; he's westbound, has filed his flight plan and knows his preferential routing. He knows the route on which he expects to be cleared out and he's going to get his "short" clearance in some five or six words. But after that, and possibly before he's completed his takeoff check, he's going to have plenty spilled at him by the controller: his heading after takeoff, the time to be at a certain altitude, the route to take after he leaves a particular fix, the altitude to maintain until he crosses another airway at a specified fix, then an immediate climb and a level off, etc. This pilot has to negotiate all that with the assumption that in the event of radio failure he'll continue as specified. Actually, there's very little margin in that operation and if he deviates from the specified route, the controllers probably would have to contact three or maybe four other airplanes in the area and get them out of his way. Therefore, the pilot has to be very accurate in his navigation. Any dropping of the ball with regard to his ATC operation or his flying can produce a situation which might cause confliction."

**Bob Jones** *(Chief Pilot, Safe Flight Instrument Corp.)* "There are times when one pilot could safely fly a DC-6, a *Constellation* or any other such airplane, and there are times when a single pilot in a much smaller airplane wouldn't be safe for just a takeoff if he had to take care of all the things that might come up in a single-engine airplane. Best answer lies in what are you going to do with the airplane and how are you going to use it. If you are going to fly under instrument conditions and in high-density areas, you definitely should have two pilots in any airplane so that you can take care of anything that might come up."

**Robert M. Woodin** *(Mgr., Air Taxi Div. of Red Bank Airport, Inc.):* "Let's look at this from the standpoint of our operation in which we are concerned 100% with airplanes that gross under 7500 pounds. That includes your light-twins and specifically excludes the Twin-Beech. Also, let's consider our rate structure and the fact that we are not subsidized in any manner. We have to make money or we don't operate. Logically, therefore, we are a one-pilot operation.

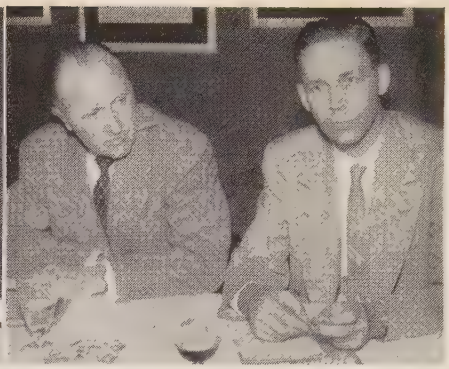
"Now the question comes up, do we ever fly IFR? CAR 42 says, 'Never in a single-engine airplane.' We agree and even go a step further. We don't think it's safe to fly a single-engine airplane at night, flares or anything else to the contrary. We have a situation now where new airplanes are coming up that we could use properly and safely in our operation but, with their inherent limitations, we could never use them and have two pilots aboard. Despite the nice looking specifications offered by the manufacturers, let's take a look at a sample one. I won't say which one. If we installed the equipment you'd need to have a safe IFR operation, we'd be in violation on gross weight alone if we had two pilots and *no* passengers at all. Therefore, we have to find out if its possible to effect a safe compromise. We think it is with the kind of compromise we're going to recommend. First of all, VFR—day or night: one pilot with the proper qualifications from the standpoint of experience and recent training can operate safely in VFR conditions with the new popular light-twins. Strangely enough, many of the comments made on why you have to have a copilot do not take into consideration the fact that it is practically impossible for a copilot in one of the new light-twins to tune any of the radios because they all are on the pilot's side. These airplanes actually don't have dual gyros, so it's only the pilot who can do any flying.

"We've even thought that, because you have no idea what the passenger sitting next to you is going to do and there isn't any door to lock between you, it'd be a good idea to include no dual controls in the regulation.

"In our opinion in our operation, we have proved it is both safe and practical for one pilot to operate a single-engine airplane in daylight VFR, and a multi-engine airplane day or night VFR and still handle whatever situation might come up.

"As far as IFR operations are concerned, we agree generally with what has been said, but weather isn't a general thing. It is much safer for

**GUEST-OBSERVERS** *at meeting were B. G. McIntyre (left) and Bill Person, former airline pilot who often has been participant*



**"TYPE** *of operation dictates need of a copilot more than airplane itself," maintained Art Graham (right, seated next to Woodin)*

**"INSURANCE** *companies consider fact that a copilot is carried," reported B. Bradenbaugh (right), "in developing the original rates"*

**"COPILOT** *should be carried on DC-3 and Lodestar-type aircraft," said Rip Strong (left), "on lighter twins, perhaps not"*

one pilot to fly IFR from LaGuardia to Allentown with 3500-foot broken to overcast and six miles than to go VFR, what with television towers, unlighted mountains, etc. Or take Elmira, N. Y., for an instrument approach, Elmira requires 2200, and anybody who tries to sneak between this low ceiling, the mountains, towers and houses would be running a greater risk than he would if he were to accept radio departure and clearance and cruise on top.

"As I said earlier, from our company's standpoint, we can only talk in terms of one pilot. And there is absolutely no possibility of our ever getting into a full IFR operation. All we'd have to do is hold an hour and a half over New Brunswick and we'd lose our profit for many trips to come.

"However, we do feel that enroute IFR with one pilot in an aircraft under 7500 gross is feasible and safe, safer lots of times than being completely uncontrolled in the same area. We also think that with a half-way decent minimum it is feasible for one pilot to accept an IFR departure when his destination is VFR and the terminal reports it will remain so until well after his ETA there."

**Baker Bradenbaugh** *(Ass't to President, U. S. Aviation Underwriters):* "What is the consensus of opinion with regard to such an emergency as losing an engine on take-off or when climbing through an overcast or on descent, in a light twin?"

**Robert Woodin:** "Most of the light-twins have good performance from an acceleration-stop distance standpoint. In practically all of the light-twins we're talking about, the Piper *Apache,* the Cessna 310, the *Twin-Bonanza* and Aero *Commander,* acceleration is very good and minimum single-engine speed is low. Single-engine climb is good too. In some cases, power stalls on either engine can be performed with the nose coming straight down in a straight line on the horizon. With one of the light-twins you can handle a single-engine by rolling the wheel into the live engine without even worrying about what your feet are doing. In all cases rudder pressure necessary is very low.

"One important fact to remember is that some of the light-twins on the market are without dual vacuum sources and you can't get dual vacuum sources. Frankly, we don't think anything should be flown IFR without a dual vacuum source. At the present time CAR-42 allows you to fly an airplane under 12,500 pounds with a single vacuum source, but we don't agree with that."

**Rip Strong:** "Do you have dual generators?"

**Robert Woodin:** "Yes, we have them on all of our aircraft. You can get any of the light-twins with dual generators either as standard equipment or optional."

**W. D. Crawford** *(Field Representative, Associated Aviation Underwriters):* "From what I can gather, most of the light-twins can be flown by one pilot under VFR conditions, much on the same basis as such larger single-engine aircraft as the *Bonanza,* the *Navion,* etc. From the conversation thus far, everyone seems to agree that when you get into heavy instrument flying there is a definite need for a copilot to help out with the work involved, regardless of whether you're flying a single-engine or multi-engine airplane. Therefore, the question seems to be whether or not you need a copilot for this intermediate flying, where you go out on an instrument clearance and then in a few minutes cancel your IFR and

(*Continued on page* 39)

**"FLYING** *under instrument conditions in high-density areas certainly requires two pilots in the cockpit of any airplane, single- or multi-engine," stated Bob Jones (left). Seated to Mr. Jones' left are W. D. Crawford and Capt. Aubrey A. Sweezey*

## ROUND TABLE PARTICIPANTS

*JEROME LEDERER, Aviation's Mister Safety, is Managing Director of Flight Safety Foundation and a human dynamo working in the interest of safe operations.*

*ROBT. E. JONES, Chief Pilot of Safe Flight Instrument Corp., holds an ATR ticket and has piled up over 8,500 flying hours. He was a Navy pilot during War*

*W. D. CRAWFORD was a Marine Corps fighter pilot during World War II and was recalled to carrier duty 1952/53 to fly F9F's in Mediterranean. He joined AAU in '46*

*AUBREY A. SWEEZEY joined Eastern Air Lines in 1953 and presently is on leave from EAL flying the TACAN-equipped DC-3 for Federal Telecommunications Lab*

*AUBREY KEIF, Manager of Aviation Division of The Texas Company, is a former newspaper man (AP and INS) and former Regional Sales Manager, Curtiss-Wright*

*BAKER A. BRADENBAUGH served as a Navy pilot during the war and as head of Experimental Department, Night Attack and Combat Training Unit, USN*

*ROBT. M. WOODIN has been Manager of Air Taxi Co., a division of Red Bank Airport, Inc., since 1953. Prior to that he was a fixed base operator and a USAF instructor*

*WILLIAM R. STRONG, Chief Pilot of National Dairy Products, joined that company in 1945. He holds an Airline Transport Rating (#22863). Base of operations is EWR*

*ARTHUR E. GRAHAM, Airways Operations Specialist at LaGuardia, is a licensed (Commercial rating) pilot. He has been an airport traffic controller for over 15 years*

# PLANE FAX

## Your Best Week-end Flight Plan for December

See the "Wings Over the Nation" Air Show at Long Beach Municipal Airport, December 19-20, Long Beach, Calif. You can get quality Standard Aviation products and service at the scene of the show.

# Flying a tow line to a stranded army barge!

**Salvage flight over breaking seas!** That was Merrill Ginn's job when an ammunition barge went aground near Long Beach, Washington. Flying from his base at Clatsop County Airport, Astoria, Oregon, he succeeded, after several attempts, in laying 3,000 feet of line from the rescue tug waiting offshore to the stranded barge, where seamen secured it for the salvage try.

"Whether I'm flying over water or on a week-end hop," says Mr. Ginn, "I always use RPM Aviation Oil to keep my engine in top condition. On longer trips I carry extra cans with me, to make sure I won't have to use anything else. It really cuts down engine wear, and ends all trouble with sticking rings and valves. I use Chevron Aviation Gasoline 80/87, too. It gives me plenty of extra power when I need it, and yet I can lean it down for economy when I'm cruising."

You'll get longer engine life and better performance for your plane if you use quality Standard Aviation Products. You can get them throughout the West with your Chevron National Credit Card. Use it for overnight tie-down charges, too—no need to carry extra cash.

## TIP OF THE MONTH

If part of your flight will be at night, it's wise to check your running lights before you take off.

T.M.'S "RPM," "CHEVRON," REG. U.S. PAT. OFF.

CHEVRON AVIATION GASOLINE

RPM AVIATION OIL

STANDARD OIL COMPANY OF CALIFORNIA

# SKYWAYS FOR BUSINESS

**News Notes for Pilots, Plane Owners Operating Aircraft in the Interest of Business**

**SKYMOTIVE'S** *new terminal at O'Hare Field, Chicago, was designed to serve the flying executive, his aircraft and crew. Fifteen companies already have leased space here*

## Flying Executives Get New Chicago Air Terminal

*Chicago, Ill.* A luxurious new air terminal has been opened for the flying executive at O'Hare Field by Skymotive, Inc. One of the important features of this new facility is the 125 by 400-ft hangar which can accommodate any aircraft presently in use. Its huge doors are power-operated and the hangar is kept at the desired temperature by radiant heating through pipes imbedded in the floor.

The newly opened business-aircraft Operations and Maintenance terminal is adjacent to the new Chicago terminal building. This enables the flying businessman to make rapid connections with scheduled airlines.

The executive who comes by car to meet or board his company's plane approaches the Skymotive Terminal via a wide driveway leading to the ultra-modern facade of the building. Porters are available to park cars in a heated garage or at an adjacent lot.

The Skymotive Terminal features a large fully equipped conference room where executives may transact business while their aircraft are being serviced. In addition there is a flight-planning center with the latest navigational charts, weather facsimile and sequence teletype, and direct phone connections with airways traffic control.

Upstairs in the terminal building are both private and public offices for company pilots, and there also is a club room with a coffee bar, card table, television and nearby shower facilities.

Among the business firms that already have leased space in the Skymotive Terminal are: Admiral Radio, Borg-Warner, Shell Oil, Container Corp., International Harvester, Crane, Pure Oil, Texas Illinois Natural Gas, Eddy Paper, Lilee Products, Radio Materials Corp., White Cap, A. Larkin & Sons, Soreng Products, and Micarta Fabricators, Inc.

Skymotive is a CAA approved repair station (Airframe—Class I and III, no limitations; Radio—Class 1 and II, no limitations). O'Hare Field's projected tangential runway system is now in the early stages of construction.

## New Coating Prevents Fog on Aircraft Windows

*Burbank, Calif.* The development of a product called "Sierracote" which prevents the formation of fog on the inner surface of aircraft windows or canopies has been announced by The Sierracin Corp.

Sierracote is electrically conductive and gives satisfactory results only on glass and on polyester plastics. At this stage of development, the product is not applicable to acrylic plastics (adhesion is not adequate).

Visible light transmission of polyester plastic sheets with Sierracote is between 60 and 70%. Uncoated plastic transmits about 90%.

Sierracote is an efficient reflector of infrared rays and will prevent much of the sun's heat from entering the aircraft through transparent areas. Hence, size and weight of aircraft air conditioning systems may be reduced proportionately.

Sierracote is currently being evaluated for several military-type aircraft.

## Super Aero Commander Goes into Production

*Bethany, Okla.* Aero Design & Engineering Co. has started production for 1956 delivery of its new model Aero *Commander* business plane. Designated the Model 680, the 1956 version of the popular *Commander* is powered by twin supercharged Lycoming GSO-48—A1A engines, each developing 340 hp for take-off and a continuous normal rating of 320 hp. This Lycoming engine was developed especially for the light-twin *Commander* and is a geared-drive, six-cylinder horizontally opposed, supercharged, dry sump, aircooled engine with side-mounted accessories.

The Model 680 cruises at 230 mph at 10,000 ft at 70% power; has a normal range of 1400 miles (maximum range: 1600 miles), a gross weight of 7,000 lbs with a disposable load of 2,750 lbs, and will carry 230 gallons of fuel.

The *Super Commander* offers optional seating arrangements for six or seven people or a five-place arrangement with two full-length lounges and special provisions

**AERO COMMANDER** *for 1956 offers the flying businessman more speed than earlier models and is the first light-twin to enter the market with supercharged engines (Lycomings*

or an ice-box, a toilet and tuckaway table. n addition, for flying at altitudes above 2,000 ft, a special console oxygen system s installed as standard equipment.

## Atlantic Aviation Orders Five from Beech Aircraft

*Wichita, Kan.* More than $600,000 worth of Beechcraft business planes were ordered recently by Atlantic Aviation of Teterboro, N. J., and Boston, Mass. Included in the order were two eight-place Beech Super 18's, wo four-place *Bonanzas*, and one four-place MS 760 twin-jet.

Atlantic's customer for the twin-jet MS 760 is Trans-Oceanic Marine, Inc., of New York, which now has the distinction of being the first corporation to place a firm order for the 410-mph twin-jet.

Atlantic Aviation, through this order for he 760, becomes the second Beechcraft distributor to place a $50,000 priority deposit oward purchase of an MS 760. The J. D. Reed Company, Inc., of Houston, Texas, vas the first by less than a month.

## peed Control System Approved or Use on the Aero Commander

*New York, N. Y.* Aero Design & Engineering Company has approved the Speed Control System as optional factory-installed quipment on the Aero *Commander*. Manufactured by Safe Flight Instrument Corp., he Speed Control System on the twinngine *Commander* enables the pilot to chieve the best possible speed for take-off, anding and low-speed operations as well as nake easy adjustments for asymmetrical ower conditions.

The Speed Control System is a simple omputer, compensating for a variety of ight variables such as power, gross weight, ap and gear position, turning and longiudinal accelerations, ground effect and ensity altitude. The instrument already as been approved for factory installation y Cessna.

## airchild Announces Plans or Executive Jet Transport

*Hagerstown, Md.* Plans for a light jet ransport designed to meet the needs of xecutive aircraft operators were disclosed ecently by Fairchild Aircraft Division. Deeloped under the Fairchild Engine and irplane Corporation's research and deelopment program, the projected sleek et transport will offer a cruising speed of 50 mph. A low-wing aircraft and desigated M-225 by Fairchild, it will carry a rew of two and seven passengers. It will e powered by four Fairchild jet engines, ave a wing span of 35 feet 4 inches, be 0 feet, 10 inches long, and have a normal ross weight of 17,695 pounds. Estimated erformance characteristics indicate the 1-225 will take off at normal gross within ,720 feet over a 50-foot obstacle and land h 1,222 feet.

This jet transport is one of several new rojects in the advanced planning stage at airchild's Hagerstown plant.

# . . . . in the business hangar

Mason and Dixon Lines, a trucking firm with headquarters in Kingsport, Tenn., has purchased a new eight-place Beech Super 18 from Piedmont Aviation, Inc., of Winston-Salem, N. C.

Pete LaFramboise and John Corrier brought Wolfe Industries DC-3 to Remmert-Werner in St. Louis for installation of a Sperry Zero Reader, two Bendix ADF's with Bendix flush loops, Collins 51V2 Glideslope, Collins 51R3 Omni, dual Collins RMI's, a Lear 2200 three-light marker receiver, Sperry C4 Gyrosyn compass, Sperry H5 Horizon, Remmert-Werner 10-channel 8-watt Isolation Amplifier with dual cockpit speakers, new radio and electrical panels, Cadillac cabin radio, rewiring and conversion from 12 to 24 volt system, dual engine change and a completely new exterior paint design. E. T. Spetnagel is Wolfe Industries' NBAA representative, and home base is Columbus, Ohio.

Frank B. Waters, Houston, Texas oil man, has purchased an executive *Lodestar* from L. B. Smith Corp., Miami. Capt. Vic Hancock is pilot of the *Lodestar* and will air-commute Mr. Waters between Houston and his extensive oil holdings throughout Texas.

Aero-Jet General Corp., Azusa, Calif., has added a Flite-Tronics CA-1 audio amplifier to its company DC-3. The installation was made by Southern California Aircraft Corp., Ontario, Calif.

Sun Oil Co., Philadelphia, is having Mattituck Airbase Corp., Linden, N. J., do a McKinnon-Hickman conversion on its Grumman *Widgeon*. The McKinnon-Hickman conversion replaces the original Ranger engines in the *Widgeon* with 270-hp Lycoming engines and Hartzell three-bladed props.

Edward Perchak flew the Lytle Engineering Company's Aero *Commander* 560 to Horton & Horton, Fort Worth for a custom-designed icebox-hassock installation and other accessories. Albuquerque, N. Mex., is home base for the 560.

McCulloch Motors, Los Angeles, has equipped its company Super 18 Beechcraft with a Flite-Tronics MB-3 marker beacon receiver. The Norman Larson Co., Van Nuys, made the installation.

Charlie Bolton of Union Chemical & Materials Corporation of Pittsburgh, recently took delivery of a DC-3 purchased from Executive Aircraft Service, Inc., Dallas, Texas. Additional equipment also was added by EAS.

Joe Morris and Tom Bante, pilots for Monsanto Chemical Co., are back from a seven-week tour of Europe in a PBY leased by Monsanto from Remmert-Werner. Company executives visited installation, customers, prospects and contacts in 19 countries and traveled over 14,000 miles in 107 flying hours. Ralph Piper is Monsanto's chief pilot and NBAA representative.

Shell Oil Company has had new auxiliary tanks, a new radio and instrument panel installed in its newly acquired *Dove*. Dallas Aero Service made the installation in the Tulsa-based *Dove*, one of five in the Shell fleet. G. G. Hughes is Shell's NBAA representative.

Henry Rouselle, pilot for L. E. Soucy of Quebec, Canada, recently took delivery of a Link-converted *Super Widgeon* for use in both Canada and the United States. The *Super Widgeon* is equipped with special Lear radio panels, Link "Whisper-Tone" safety exhaust system, and long-range fuel tanks manufactured by Link Aeronautical Corp., Endicott, N. Y.

Boots Johnston and Ken Riggs were at Engine Works in St. Louis for installation of two fresh Super-92 engines in their Lario Oil DC-3.

Atlantic Aviation Service, Lynchburg, Va., has been named a Scintilla Aircraft Service Station. Atlantic will service Lynchburg, Roanoke and southwestern Virginia.

The Massey-Harris, Ltd., de Havilland *Dove* is back in operation after the installation of exhaust augmentors, heaters, and a double engine change by Dallas Aero Service. B. G. Smith flew the *Dove* from Toronto to Dallas for the work. Also in the Dallas Aero hangar at the same time was the Massey-Harris (Racine, Wis.) *Dove* flown by L. V. Brandhorst. The State-side *Dove* also had an augmentor installation, a double engine change, and installation of a new radio. B. G. Smith is Massey-Harris' NBAA representative.

The three *Twin Bonanzas* recently purchased by Lockheed have been equipped with Flite-Tronics MB-3 marker beacon receivers. Installation was made for Lockheed at the Beech plant in Wichita.

Cotton Jeter flew the Union Producing Company DC-3 to Executive Aircraft Service, Inc., for installation of modified oil tanks and system, and miscellaneous repairs. Home base for the DC-3 is Shreveport, La.

# FUELS-OILS

**Features and Facts Pertinent to Successful Flight Operations**

## Boeing Field Gets Super-Service Fuel for Big Jet Bombers

To satisfy the king-sized fuel-hunger of big eight-jet Boeing B-25 heavy bombers at Boeing Field in Seattle, the Air Force has opened one of the fastest, biggest fueling facilities in the air world.

The fueling station enables the big bombers to park in a row a quarter-mile long to receive their fuel at the rate of 1200 gallons per minute.

Four of the bombers can be served at a time, with a hydrant and hose for each. The hydrant-hose arrangement was selected to increase pump capacities beyond anything reasonably possible by using tankers and taking the fuel to the plane rather than the plane to the fuel.

Three 40,000-gallon underground tanks store the jet fuel at the Boeing facility. The storage tanks are emptied by three 75-hp pumps which push the jet fuel into and through filters and water separators and then into a manifold that serves the ground-level hydrants. If desired, fuel already delivered into the aircraft tanks may be drawn back out and returned to the storage tanks.

An attendant in a green-glass control room push-buttons the entire fuel-flow operation. From the control room there is a full view of the entire 1,000 by 500-foot fueling facility which is located on the northwest side of Boeing Field. Inside the control room, beside the group of switches for fuel pumping, there also is a group that controls fire-fighting devices.

Perhaps unique insofar as outdoor installations go, part of the fire-fighting equipment consists of rows of waterfog nozzles set just below the level of the concrete along the fueling strip. In action, spray from these nozzles forms a wall of water mist between airplane positions. This both prevents the spread of fire and keeps the entire area cooled off below combustible heat levels.

Other waterfog nozzles, as well as regular hydrants for fire hoses, are located around the area while, of course, chemical foam also is available to smother jet fuel or oil fires. The foam equipment available will cover the entire station floor with a blanket of bubbles three inches deep in less than one minute.

According to Boeing, in its announcement of the facility, this new super-station offers just about every service except "windshield cleaning."

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## Segregated Fueling Systems Part III: Satellite Tanks

*(Because of the revived interest in and appreciation of segregated, as opposed to commingling, airport fueling systems, SKYWAYS, in co-operation with the Aviation Technical Service Committee of the American Petroleum Institute, has been conducting a survey series on various segregated fueling systems applicable to a wide range of airport situations. This month's third and concluding installment involves a particularly fortunate airport situation—one in which fuel may be delivered by the most economical of methods, barge service.*

*Idlewild and San Francisco are examples of this situation. At such airports, of course, initial storage is most expediently provided in the vicinity of the point at which the fuel barges unload. From that point, the system requires satellite tank storage and servicing.—Ed.)*

Anchor of the fueling system, of course, is the bulk-fueling area. In this case it would be at the barge unloading point and is not shown on the diagram.

Its capacity is assumed to be 300,000 gallons distributed in twelve 25,000-gallon tanks. Fuel from the bulk-storage tanks is pumped through eight two-and-a-half-inch lines. The satellite tanks served by these eight lines are of 5,000 gallons capacity apiece.

The pumps sending the fuel from bulk to satellites are of only one horsepower apiece, one to each of the eight lines. (Equivalent commingling systems probably would use comparatively huge eight and 10-inch lines from bulk storage to pit areas and would need about fourteen 25-hp pumps to keep those large-bore tubes filled and flowing.) The pumps used to deliver fuel to the planes in the segregated system being discussed here would be of 20 hp apiece and eight would be used.

The airport here, as in the other systems discussed, would be a 16-gate proposition serving four airlines, each of which requires two different grades of fuel.

As an example of real situations that develop—and which these segregated systems are designed to satisfy—Airline "A" may need Grades 91/96 and 100/130 octane, while Airline "B" may be flying its service on 100/130 and 115/145 octane.

A survey has shown that most airlines have and plan to continue using no more than two grades of fuel at any one airport. Yet, if an airline did decide at some point that it had to have a third grade available —as it might with turbine aircraft in operation—the segregated fueling system could be expanded to provide that third grade *and at the airline's own gate-fueling position* by simply installing an additional satellite tank and the connecting pipes.

Looking at the schedules of major airlines at airports using systems such as the one illustrated here has shown that a flow of 25 gallons per minute from the bulk storage area into the satellite tanks will keep them at least 50% filled even during peak consumption periods.

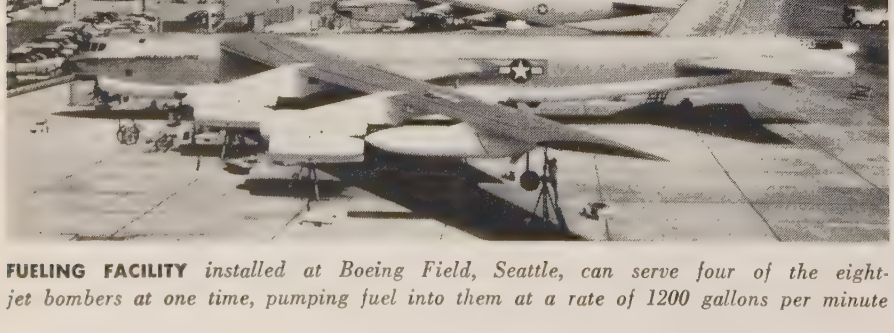
Optimistically, however, the pumps at the bulk-storage area and the piping from the bulk tanks to the satellite tanks are designed, actually, for a flow of as much as 40 gallons per minute!

What this means in terms of future utility and expansion of the airport is simply that a 60% increase in fuel consumption at the 16 gate positions can be handled with the original installation. That increase, in turn, is just about the fuel required for the maximum number of flights that could be handled from a 16-gate airport anyway. Thus, theoretically, as long as the field lasts, the fueling system should last.

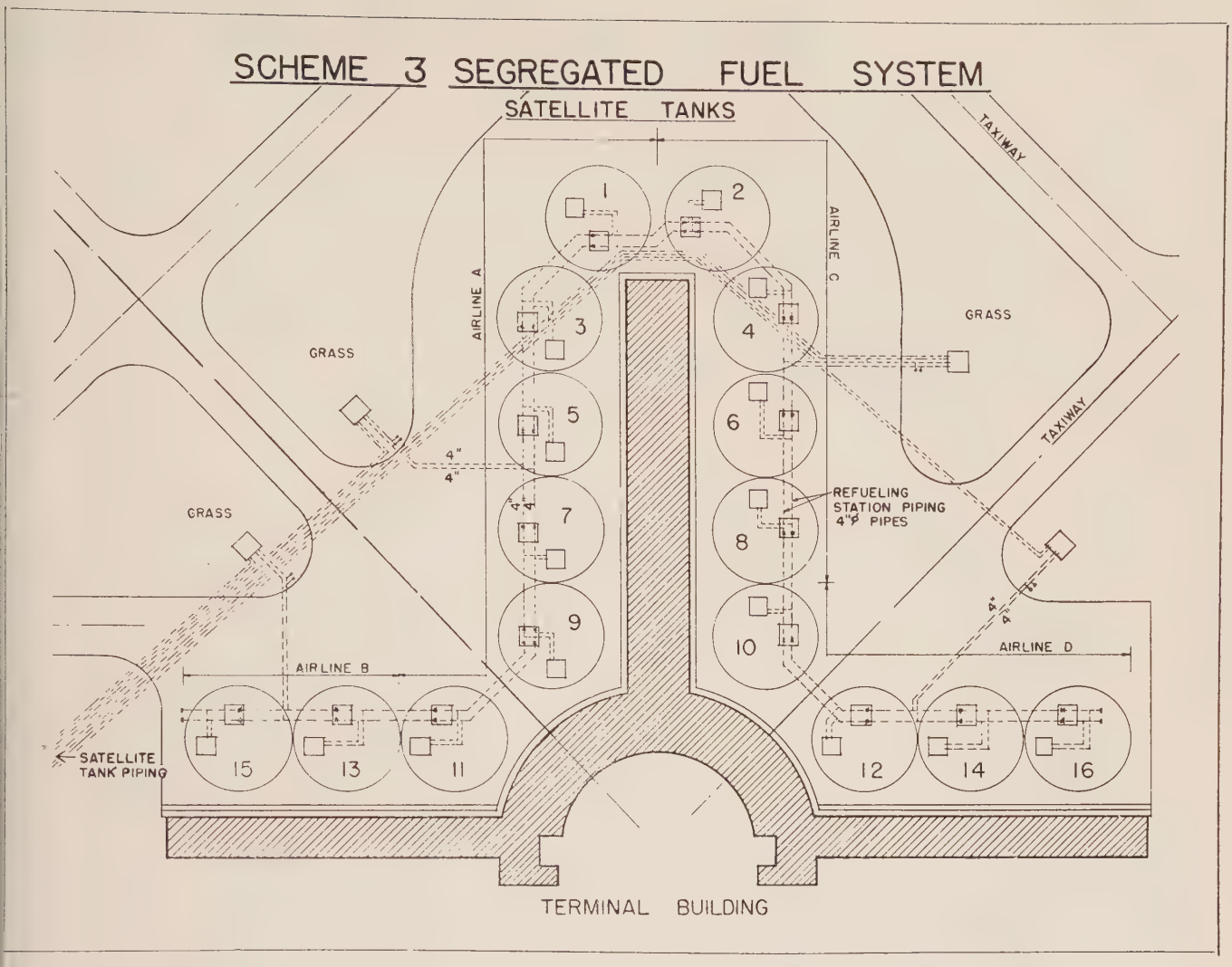
The pumps that feed satellite tanks are located at the bulk-storage positions. The pumps to fuel the aircraft are located immediately above the satellite tanks.

These pumps, from the satellites, and the piping leading to the pits or hydrants are sized so that they can deliver fuel to the aircraft at a rate of 600 gallons per minute per airline per grade of fuel. This would permit each of the four airlines to simultaneously fuel two aircraft with the same grade of fuel at 300 gallons per minute or three aircraft at 200 gpm.

Here again this fuel-rate seems about high enough for all contingencies because in point of fact and regardless of the



**FUELING FACILITY** *installed at Boeing Field, Seattle, can serve four of the eight-jet bombers at one time, pumping fuel into them at a rate of 1200 gallons per minute*




number of flight schedules and aircraft actually on the apron at one time, it seems improbable that sufficient fueling crewmen would be available to perform simultaneous fuelings in excess of those provided for.

Flexibility in the system is assured in both the storage and delivery of fuel in many other ways, however.

Any number of tanks in the bulk storage area can be assigned to an airline and/or a supplier and then manifolded to any satellite tank. Any series of gate positions can be served by satellite tanks by positioning the valves in fueling lines leading from the tanks to pits.

A large number of grades of fuels may be readily handled on the airport since each satellite tank is, in reality, an independent fueling system and can handle any grade of fuel desired. Provisions also may be made to load aircraft fueling trucks by "under-filling" them from a connection adjacent to the satellite tanks.

Economically, however, this system would seem to present an unfortunate contrast to the other segregated systems described in this series. Whereas the others have been estimated as costing actually less than equivalent systems involving the commingling of brands of the same grade of fuel, this third system has been estimated as costing from 12 to 18% more than equivalent commingling system. Recalling, however, that the system of delivery used in this plan (barges) is considerably less expensive than the deliveries envisioned in the other systems, the initial cost is softened by long-term benefits.

**Complaints and Conclusions:**

In studying the segregated fueling systems there may have been some questions raised as to the nearness of storage tanks to terminal buildings. The tanks-to-terminal distances have been between 350 and 450 feet. Is this safe?

Here is how aviation technicians of the American Petroleum Institute have answered that: "It is felt that too much emphasis has been placed by various Airport Authorities, Consultants, etc., on the designation of one remote area on an airport as a 'tank farm area' or 'bulk storage area.'" The tank-to-terminal distances in the segregated systems that have been reviewed here are termed "certainly not dangerous." For emphasis, it might be well to remember that distances involved in the segregated systems under discussion are from one to one-and-a-half times the length of a football field.

Furthermore, these tanks are below ground and do not offer any obstacle to wing tips or airport traffic. The API technicians add that "they are located in areas which could not support the weight of a modern airplane, therefore, the areas are not subject to aircraft or vehicular traffic. Vent lines from these tanks would be carried only a few feet above ground. Such lines would present no greater obstacle than runway lights."

It is pointed out also that at many airports—Chicago as an example—large-capacity storage tanks have been located immediately adjacent to hangars and other buildings, with tender-loading facilities and vent lines carried within inches of the building walls themselves. These tanks, in turn, are filled by transport trucks standing within 15 to 30 feet of the structures.

Another point in conclusion is that in each of the layouts shown, each supplier can fill tenders at the storage area assigned to him. Concrete turnouts are provided for the parking of transport trucks or airport tenders completely off the ramp area. Since the wing tips of transport-type aircraft easily clear the height of these vehicles, no ramp area is lost to taxiing planes.

In summary of the segregated systems: they provide complete product segregation, equal safety, and more assurance that the field will never be shut down for lack of fueling facilities. Too, in the upcoming era of many-graded fuels for turbine operations product segregation will become more than a brand desirability; it will become a technical necessity. Finally, so far as the suppliers of fuels themselves always have been concerned, segregated systems mean getting *exactly* the fuel asked for in proper extension of the competition that has made American aviation fuels the standard of the world.

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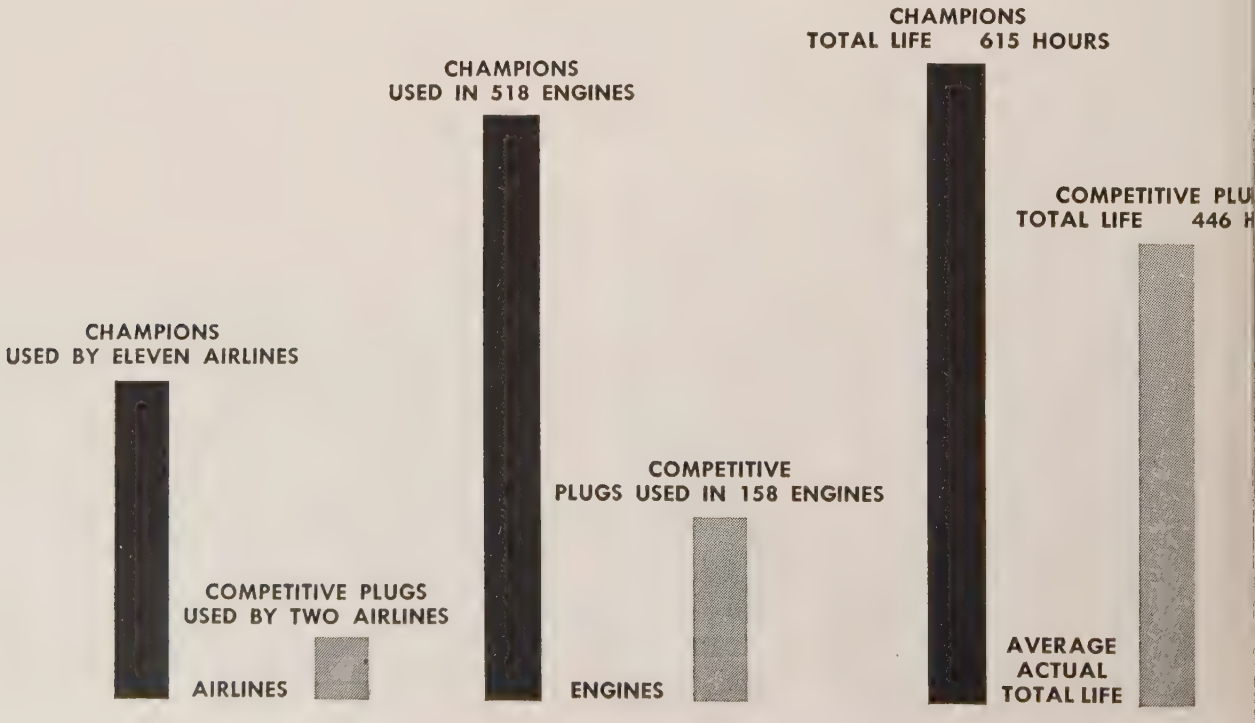
|---|---|---|---|---|---|
| AMERICAN | DC-7 | 27 | Champion | 108 | .... |
| DELTA C&S | DC-7 | 10 | Champion | 40 | .... |
| EASTERN | DC-7 | 9 | Other | .... | 36 |
| | L1049C | 16 | Other | 3* | 61 |
| NATIONAL | DC-7 | 4 | Champion | 14 | 2* |
| NORTHWEST | L1049G | 4 | Champion | 16 | .... |
| PAN-AMERICAN (Atlantic Div.) | DC-7 | 9 | Champion | 26 | 10* |
| TRANS-WORLD | L1049G | 20 | Champion | 80 | .... |
| UNITED | DC-7 | 25 | Champion | 100 | .... |
| KLM | L1049C | 12 | Other | 2* | 46 |
| AIR FRANCE | L1049C-G | 18 | Champion | 69 | 3* |
| TRANS-CANADA | L1049C | 7 | Champion | 28 | .... |
| SEABOARD & WESTERN | L1049D | 4 | Champion | 16 | .... |
| LUFTHANSA | L1049C | 4 | Champion | 16 | .... |

*Evaluation Test



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IRLINES • MARITIME CENTRAL AIRWAYS • ISRAEL AIRLINES, LTD. • SERVICOS AEREOS CRUZEIRO DO SUL, LTDA. • CONTINENTAL AIR LINES
AIRLINES • DELTA-C & S AIR LINES, INC. • EASTERN AIR LINES • FLYING TIGER LINE • FRONTIER AIRLINES
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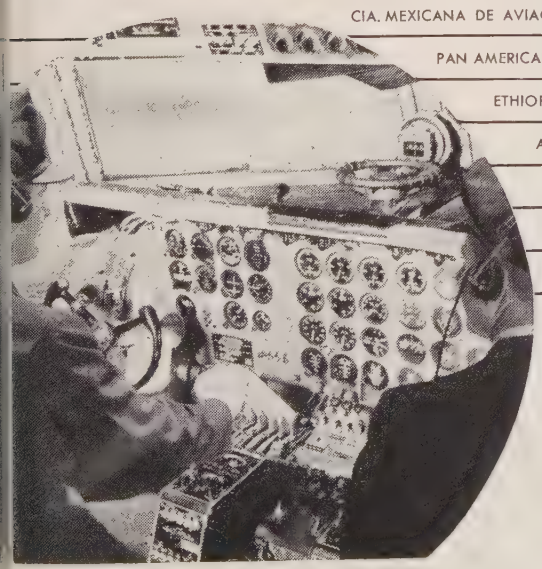

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# Official NBAA Report

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## NBAA's Eighth Annual Meeting and Forum Sets New Records

Acclaimed as one of the "most successful and constructive" conventions ever held, the eighth annual meeting and forum of the NBAA also broke all previous attendance records. Final count on official registration was 517, which exceeded the previous Dallas mark of 432.

Convention headquarters were in the Sheraton-Cadillac Hotel in Detroit, Michigan, October 5-7. Delegates were present from all sections of the nation and Canada and included more top officials of business-aircraft users than any of the previous NBAA annual conventions. The meeting was noteworthy, too, for the large representation of Federal, State and Municipal officials. Presidents of several large aviation associations were present, such as the National Aviation Trades Association (NATA), Airport Operators Council (AOC), and key officers from the Air Transport Association (ATA), International Military Air Transport Association (IMATA), Air Line Pilots Association (ALPA), Aircraft Owners and Pilots Association (AOPA), Aviation Writers Association (AWA), Aero Club of Michigan, National Association of State Aviation Officials (NASAO), Aircraft Industries Association (AIA), Aviation Distributors and Manufacturers Association (ADMA), American Association of Airport Executives (AAAE), Air Force Association (AFA), National Safety Council (NSC), Kansas Women's Aeronautical Association (KWAA) and many others.

## New Alignment of NBAA Officers Announced at Detroit Meeting

NBAA launched its ninth year of service to its members with the following slate of officers:

Henry W. Boggess, Sinclair Refining Co., of Tulsa, Okla., re-elected President; Walter C. Pague, ARMCO Steel Corp., Middletown, Ohio, elected National Vice President; Gerard J. Eger, International Harvester Co., Chicago, Ill., re-elected Treasurer; Jean H. DuBuque, NBAA National Headquarters, Washington, D.C., re-elected Secretary and continued as Executive Director of the Association. Newly elected Board members were: Curt G. Talbot, General Electric Co., Schenectady, N. Y., and Robert C. Sprague, Jr., Sprague Electric Co., North Adams, Mass. Eugene T. Spetnagel, Wolfe Industries (Aviation), Columbus, Ohio, was re-elected to another term on the Board. All three members will hold office until 1958. Other members of the Board of Directors are: Ralph E. Piper, Monsanto Chemical Co., St. Louis, Mo., Cole H. Morrow, J. I. Case Co., Racine, Wisc., Joseph B. Burns, Fuller Brush Co., Hartford, Conn., and William B. Belden, Republic Steel Corp., Cleveland, Ohio.

## Top Industry and Federal Leaders Address Convention

Principal speakers at the convention included: Dr. John H. Furbay, Education Director of TWA, at the "First-Niter" dinner; Charles F. Kettering, Vice President Emeritus of General Motors Corp., at a "Get Acquainted" luncheon; CAA Administrator Fred B. Lee at the annual awards luncheon; and Gill Robb Wilson, President of the Air Force Association, at the Honors Night Banquet.

Furbay, internationally known lecturer, author, and director of the Global Air Education program of Trans World Airlines, told the association members and guests convened at the Wednesday "First Niter" dinner, that "We must recognize that the standards by which we judge progress and superiority are not necessarily the standards used by other people. With mass air travel on the part of Americans, the problem which faces us is, 'How can we neutralize the attitudes of intolerance and prejudice, and create travelers who will not offend their world neighbors who now have been brought so close?'" He urged genuine appreciation of other peoples, their history, philosophy and contribution to world culture.

Henry W. Boggess, President of the NBAA and an official of the Sinclair Refining Co., of Tulsa, Okla., presided at the dinner meeting. In introducing Dr. Furbay, Boggess said, "He has become known as one of America's most dynamic and inspirational exponents of the international scene, and has received many awards for his outstanding service in interpreting our air-age world as we know it today."

John P. Gaty Vice President and General Manager, Beech Aircraft Corp., Wichita, Kansas, was recipient of the 1954 annual business flight safety award of the Women's Aeronautical Association of Kansas. He was the unanimous choice of a special awards committee composed of association, industry, state and federal representatives.

Administered by the NBAA, the annual award of the Kansas Association is one of the highest honors bestowed upon a person in industry who has consistently and effectively contributed to the advancement of business flying safety.

A silver trophy was presented to Gaty during the dinner meeting. Merrill C. Meigs, Vice President, The Hearst Corp., Chicago, Ill., long prominent in National Aviation circles, made the presentation for the WAA.

When presenting the trophy, Meigs said, "Mr. Gaty's safety promotion efforts have been recognized since 1934 when General Electric Co. accepted his lighting studies. These were followed by his booklet 'Kinetikos' for promoting business flight safety. Later, the Beechcraft safety suggestion series became an internationally known business flight safety aid and guide."

Ann Morton, President of the WAA, before introducing Meigs, stated "Facts of safety are important to all women whose husbands fly on business trips. It is our purpose in making this award to allay any misgivings that business flying in company-operated aircraft is less safe than other forms of air transportation. Statistics have proved otherwise."

Charles F. Kettering, Research Consultant, General Motors Corp., was the main speaker at the special "Get Acquainted" luncheon Thursday.

Kettering, internationally known industrialist, inventor and researcher, spoke on future developments in the business flying field. He predicted a "Bright future for the expanded use of aircraft as an adjunct to business and industry, particularly for organizations that are planning to decentralize much of thier main plant functions to other sections of the nation."

Sharp verbal blows at almost every phase of aviation also were struck by "Boss" Kettering. Detroit's muddled airport situation received some of his most stinging comments. "Evidently," he said, "a great many people are trusting to the idea that you don't have to think ahead." He considered it ridiculous "that in this great city (Detroit) we have to drive way out into the country to get to an airport, when right across the river there is good flat land we could undoubtedly rent."

"The things you have to do outside of aviation just to get the very simplest things done inside of aviation," he said, "are amazing."

"We could have a nice airstrip right along this waterway," Kettering said, pointing to the Detroit River in front of the Veterans Memorial Building, where he was speaking, "except that there's probably an ordinance against it."

Within five years, Kettering predicted, there probably wouldn't be a large airport built without government condemna-

tion of land. Why not do it now? he asked. Aircraft manufacturers' failure to design and build planes for business and industry use, that area of aviation's most tremendous future growth, was also scored by Kettering.

The old DC-3's and Lockheed *Lodestars* now in use, the 79-year-old inventor said, were "second-hand buses." Something also must be done by the manufacturers, he said, to design planes at reasonable cost so more persons can buy them.

"Everyone says," Kettering observed, "that the cost is high because the production is low. When you ask why the production is low, they'll say its because the cost is high." Kettering who flew with the Wright Brothers and still flies his own plane, often commutes in his twin-engine Piper *Apache* from his home at Dayton to his work in Detroit.

Price of the Piper *Apache*, he added quietly, isn't so high—"just the cost of seven Cadillacs or 18 Chevrolets."

NBAA Presidents Henry W. Boggess presided at the luncheon which was toastmastered by Board member Joseph B. Burns.

A 10-year program of improvements in air traffic control and navigation was outlined Friday at the annual awards luncheon by CAA administrator Frederick B. Lee.

He told the association that "we must take positive action to keep tomorrow's growth from being throttled by limitations of the airways system."

The CAA head said that "if the nation is going to spend more than 100 billion dollars in the next 10 years on civil and military aircraft, it is a real bargain if we can make possible full utilization of those planes by investing a fraction of one percent of their cost in an adequate airways system."

Lee predicted that "it will be necessary to more than double the present number of navigational aid installations" in order to provide coverage of the entire airspace between 18,000 and 75,000 feet for turbine-powered planes, and of the CAA airway routes down to 700 feet for pilots of smaller aircraft who fly under clear-weather rules.

More radar will be needed for traffic control, Lee said, pointing out that under present methods "a block of airspace 100 miles long would need to be reserved for each jet."

Lee said CAA also was planning an expanded airport program "to keep a log jam from developing on the ground." Federal aid, he stated, will go to communities which demonstrate need in terms of present or forecast activity, with priority to projects where saftey is involved.

New navigation and air control aids are on the way, he said. One is a navigation aid to cover the entire airspace from five to 14 miles up. Another is a new radar beacon sytsem which cuts through rain and is coded to provide positive identification of aircraft. This will be ready for installation early in 1957. Lee also announced that because of "increased military capability," the government has decided to ease flying restrictions over strategic defense areas. He said Nov. 15 is the tentative date for inauguration of the new policy.

Currently there are many large "Air Defense Identification Zones" (ADIZ) in the United States. Pilots flying into an ADIZ must identify themselves by filing a flight plan with Civil Aeronautics Authorities. Lee said ADIZ regions will be eliminated from the west coast and northeastern states. They will remain over the Atlantic and Pacific, off the shoreline, and along the Canadian and Mexican borders. Two new control zones, narrow bands from Idaho to Arizona and Minnesota to Florida, will be established as a double check against possible attacks, Lee added.

At the luncheon, Lee received a special citation from the NBAA for distinguished service in the advancement of civil aviation.

The citation was presented to Lee by NBAA President, Henry W. Boggess, who presided at the luncheon. In awarding the certificate, Mr. Boggess said, "Practically every business, military and airline aircraft user today owes a debt of gratitude to Fred Lee for his substantial contribution to the progress of aviation since he took office as CAA administrator. His understanding of the complex problems facing all segments of air transportation in connection with safety, airports, communications, air navigation, has greatly advanced development in these fields."

The engraved citation presented to Lee read: "In recognition of his outstanding individual initiative and leadership as Federal Administrator of Civil Aeronautics, his far-sighted concept of industry problems, and his loyalty and devotion to the advancement of safety, navigation and utilization of aircraft in all forms of transportation."

Gill Robb Wilson, President of the Air Force Association, was the principal speaker Friday night before the Eighth Annual Banquet and Honors Night of the NBAA, closing the three-day convention.

Wilson told some five hundred representatives of leading national business and industrial concerns owning and operating airplanes, and municipal, state and federal officials on hand, that "Today a vast new civil airfleet is at work in our land, plying the skylanes day-by-day in behalf of American business and industry. These airplanes —21,500 strong—are indispensable 'tools' for modern successful competitive enterprises."

Commenting on the pressing need for public school education on aviation subjects Wilson said, "Of seven million high school students now in classrooms in the United States, less than one-half of one per cent are exposed to accredited aviation subjects in any category—scientific, vocational, cultural.

"Can the aviation industry draw an increasingly necessary volume of engineering talent from such a background?" he asked. "Can air commerce man the ramparts of world trade from such a lack-lustre horizon? Can military aviation recruit quality youth from this vacuum of motivation? Can the local air scene be other than a weed-grown relic of a discouraged dream while the lap of the air ocean does not reach the ear of a boy at a desk? And if air industry and commerce and defense and community progress are bereft of intellectual concept in the origins—what of the nation and its tomorrows?

"Is this then a signal to throw stones at the schools and the educators?" Mr. Wilson added. "Certainly not. This is a signal to 'cast the beam out of our own eye' and afterward, if the educator is found to have a bit of dust in his eye, we can lend him a handkerchief.

"The efforts of aviation to create national air consciousness have been sincere and unselfish, but patently ineffective. At the level of the public press, with a few notable exceptions, air concept is anything but progressive. At the level of national defense there is no indication of deliverance from intra-service politics. The congress has a scattered few individuals with knowledge

**NBAA PRESIDENT** *Henry W. Boggess was presented the key to the City by The Honorable Albert E. Cobo, Mayor of the City of Detroit, at opening of NBAA's Eighth Annual Meeting*

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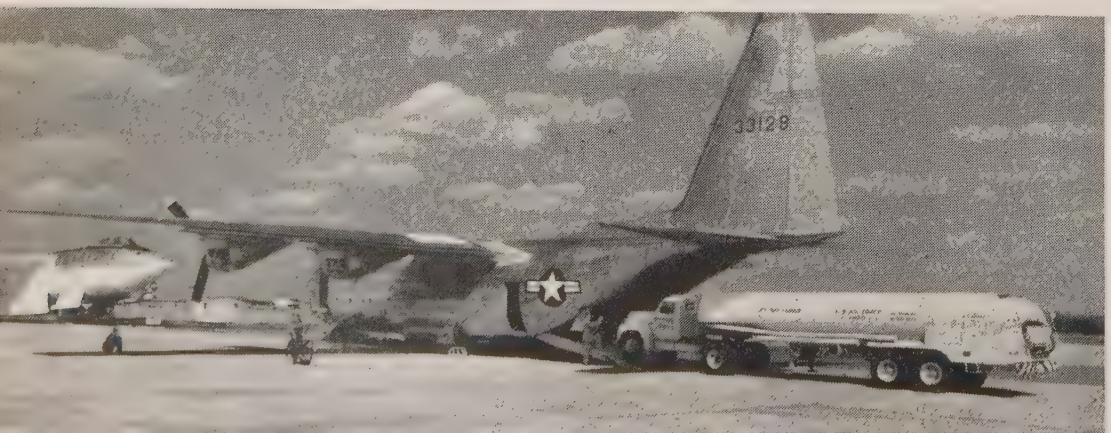
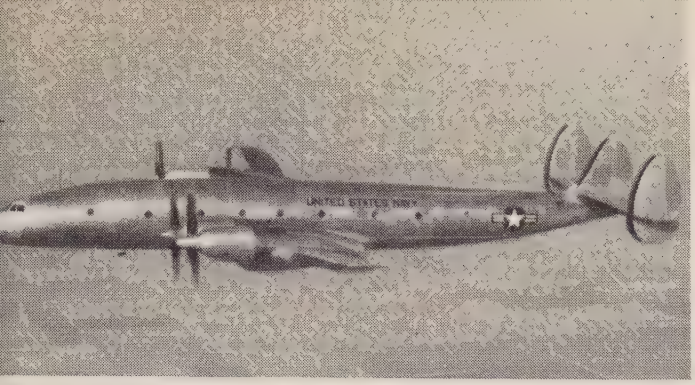


**C-130 HERCULES, NEW PROP-JET COMBAT CARGO PLANE**—Husky brother of the Electra. A 62-ton carryall, to transport men and materiel farther, faster and at less cost than any other plane! Now in production at Lockheed's Georgia Division, U.S. Government Aircraft Plant No. 6 at Marietta. As shown, a huge 5,000-gallon gasoline tank-truck can be driven up the ramp into the interior of a C-130. In background, Lockheed-built B-47 USAF jet bomber



**EW JET-POWERED SUPER CONSTELLATION.** Achieved by substituting prop-jet power for piston engines—a remarkable increase-in-speed transrmation made possible by the rugged construction and advanced basic design of e time-tested Lockheed Super Constellations. Result: the fastest propeller-driven rliner in the world! The USAF C-121F and the U.S. Navy R7V-2 are now ıdergoing exhaustive flight testing.

**T2V-1, CARRIER-BASED JET TRAINER.** The world's safest jet plane. Embodies Boundary Layer Control and aerodynamically actuated slats on wing's leading edge.

**F-104, STILL-SECRET JET FIGHTER.** (Photo restricted.) A top USAF officer said: "This is a fighter pilot's dream. We feel confident that it is the fastest, highest-flying fighter in the air, anywhere."

**THE BRIGHT FUTURE OF FLIGHT.** At Lockheed's Missile Systems Division and at other Lockheed research centers, over 2,000 scientists are deeply engaged in projects involving rocket power, ram-jet engines and nuclear energy.

# .ockheed

*'RCRAFT CORPORATION*

*California Division, Burbank, Calif.*
*Georgia Division, Marietta, Ga.*
*'ssile Systems Division, Van Nuys, Calif.*
*.ockheed Air Terminal, Burbank, Calif.*
*ckheed Aircraft Service, Burbank, Calif.*

)K TO LOCKHEED FOR JET LEADERSHIP, TOO

**1954 SAFETY AWARD** *of Women's Aeronautical Assn. of Kansas was presented to Jack Gaty of Beech Aircraft (left) by Ann Morton, president of WAA, and Merrill C. Meigs, Hearst*

and vision concerning the significance of a national air policy but, as a body, is apathetic.

"The long and short of the entire situation is that public opinion is not well grounded enough to force greater interest in the subject at significant points. And whether we like it or admit it, the fact is that public opinion is king in these United States. Leaders are only leaders, so called, as long as they follow public opinion. If that opinion is not thoroughly grounded, our leadership in significant respects is inadequate to our needs. To assure the best possible tutelage of public opinion is, therefore, a major project of the democratic process."

Wilson urged the member-pilots of NBAA to cooperate at the local level with public school educators, stressing that their professional knowledge and experience would prove a valuable aid in advancing aviation education. "Our cue," he said, "is to make available to the key men of public education the same comprehensive knowledge that we ourselves possess. If we truly believe in our cause, we must also believe that they likewise will see what is involved, and be motivated to action."

Toastmaster for the annual social affair of the NBAA was Jennings Randolph, former Congressman from West Virginia, and now assistant to the President of Capital Airlines.

## Safety Award, Presented to NBAA Member Organizations

Highlighting the three-day convention was the presentation of annual safety awards to member organizations and first pilots with outstanding safety records in business-flying operations.

Walter C. Pague, Chief Pilot for ARMCO Steel Corporation, Middletown, Ohio, and Chairman of the Awards Committee, stated that the annual awards had two important objectives: "First, to focus public awareness on the remarkable safety records being established by business organizations operating aircraft and, second, to call attention to the tremendous growth of business flying throughout the United States." Rules and regulations governing the selection of NBAA recipients, he added, were rigid and based on the accident reporting standards established by the American Standards Association and the National Safety Council. The latter organization officially endorses the annual awards and authorizes the use of the "Green Cross" on the certificates.

At the NBAA annual luncheon on Friday, Pilot Safety Awards were presented to the first pilot of each member organization who has flown 500,000 or more accident and injury free miles.

The 69 recipients of this award represented a total of 55,785,995 miles of flying without accident or injury. Fifteen of the first pilot recipients were "Million-Milers" who had flown safely 18,179,225 plane miles in business aircraft.

The Meritorious Safety Awards were conferred upon member organizations at the NBAA Annual Banquet and Honors Night Friday evening. To be eligible, these members must have flown business-owned aircraft 1,000,000 or more accident and injury free miles.

There were 19 recipients of this award, representing a total of 35,450,367 miles flown without accident or injury.

All recipients will receive engraved certificates from the association attesting to their significant contribution to the safety, progress and development of business flying.

In presenting the awards, officially endorsed by the National Safety Council and bearing the well-known "Green Cross," NBAA President, Henry W. Boggess said, "The remarkable accident and injury free record that has been made and is being made by company-operated business aircraft is positive proof that this important and fastest growing segment of non-commercial civil aviation is observing sound safety principles and practices in day-to-day flying to all corners of the nation."

Leading the list of member companies in number of accident-free miles was Monsanto Chemical Company with a total of 4,272,894 miles, followed by Burlington Industries with 3,188,961 and Great Lakes Carbon Corporation with 2,389,636. Others receiving safety certificates were:

Columbia-Geneva Steel, 2,301,544; Ford Motor Company, 2,300,000; Southern Natural Gas Company, 2,147,989; Hercules Powder Company, 2,104,035; Corning Glass Works, 2,102,565; Gulf Oil Corporation, 1,810,380; International Paper Company, 1,658,714; Minneapolis-Honeywell Regulator Company, 1,424,000; Owens-Illinois Glass Company, 1,412,646; General Electric Company, 1,376,200; The Procter & Gamble Company, 1,264,277; Shell Oil Company, 1,250,000; Anchor Hocking Glass Corporation, 1,232,200; Slick Enterprises, 1,114,000; Holley Carburetor Company, 1,080,326; and Thompson Products, Inc., 1,020,000.

Nelson U. Rokes of the Procter & Gamble Company led the 15 "Million-Milers" in the pilot safety award category with a total of 2,779,548 safe plane miles flown consecutively. John A. Lyon of Malco Refineries was second with 1,400,000 and B. Owen Mayfield of Hercules Powder Company was third with 1,318,900.

Other "Million-Milers" by numbers of miles flown: George E. Meyers, Monsanto Chemical Company 1,120,000; William B. Hobson, Hercules Powder Company, 1,109,580; Wilfred R. Dotter, International Harvester Company, 1,107,000; Richard N. Thurston, Monsanto Chemical Company, 1,094,878; Norman L. Mitchell, Minneapolis *Star and Tribune*, 1,055,250; George C. Pomeroy, Swiflite Aircraft Corporation, 1,050,000; Raoul Castro, International Harvester, 1,040,000; Ralph E. Piper, Monsanto Chemical Company, 1,038,000; Harold J. Bowen, Corning Glass Works, 1,021,625; S. M. Maxwell, Burlington Industries, 1,020,744; Carl J. Lund, International Paper Company, 1,014,800; and Thomas J. Schuetz, International Harvester, 1,008,900.

Other first pilots receiving awards for having flown 500,000 accidents and injury free miles were: Wilbur D. Adams, The Procter & Gamble Company, 505,636; Howard E. Ahrns, The Ohio Oil Company, 742,470; Warran E. Ames, Hercules Powder Company, 511,000; James M. Banker, ARMCO Steel Corporation, 577,500; Earle W. Bauer, The Ohio Oil Company, 608,770; Wm. N. Benedict, Ford Motor Company, 762,700; David H. Bishop, Sinclair Refining Company, 703,080; Arthur D. Boswell, International Paper Co., 627,109; John A. Bouteller, Jr., Service Pipe Line Company, 831,510; Bill G. Davenport, Service Pipe Line Company, 876,250; C. E. Dillahunty, Shell Oil Company, 612,500; Julien W. Freeman, Shell Oil Company, 575,152; James G. Guess, Burlington Industries, Inc., 817,077; W. F. Holbrook, Socony Mobil Oil Co., 728,000; K. F. Horton, Sinclair Refining Company, 615,000; Wilmer A. Ivey, Southern Natural Gas Co.,

(*Continued on page* 43)

# Airways Traffic Requires VOR Equipment Vigilance

*"It is anticipated that from the standpoint of accuracy there will be no need for a replacement for the VOR/DME in the foreseeable future"*—ANDB Report (July 1, 1951).

The recent controversy over TACAN has concentrated so much attention on the policy debate that it has almost masked a much more important question, namely, the actual working accuracy of VOR in situations where accuracy is the key to safe operation.

No one questions the superiority of VOR over the old-fashioned LF four-course ranges. The aural interpretation of a range leg with its bends, fades and virtual unreadability in bad atmospheric conditions precludes any desire to return to that form of air navigation. The limitations in number and placement of airway courses hampered the airway system sometime ago and only added to the congestion that was already approaching unacceptable proportions.

So the introduction of VHF Omnidirectional Ranges (VOR) was a welcome development to pilots and airways' planners alike. The ease of following a visual track-guidance indicator in the cockpit freed aircrews for the growing burden of ATC communication. Ability to select and fly innumerable courses anywhere within the reception range of a VOR enable the planning and introduction of accurate high-altitude direct courses on long flights and increased the number of entries and exits to and from high-density areas. VHF reception characteristics in bad atmospheric conditions were an added premium if not the most important major advantage.

This all being so, why any dissatisfaction with the VOR system? Why any justification for the expenditure of government funds or private capital to develop any system more accurate? (Note: There is no intent here to enter into any discussion of DME *vs* TACAN. This deals solely with the current VOR airway system.)

The answer lies partially in the *Airmen's Guide* where, ever since the commissioning of the first VOR, it has been necessary to NOTAM-ize an amazingly high proportion of unreliable courses. The effect has been so evident that the practice recently has been to speak instead of the "coverage," meaning *those azimuth portions* of the entire compass rose in which at *certain specified minimum altitudes*, often below enroute airway minimums, the particular VOR signals *are acceptably accurate!*

Siting had been a problem and many VOR's have been installed after long and tedious testing, only to have to be uprooted and re-sited after more lengthy testing. Late developments in antenna arrays as well as masking techniques have gone a long ways towards correcting these difficulties. In some instances the unreliable and inaccurate courses have been happily located in quadrants where no desired airway segments are involved and, although the omni-directional qualities are thus not strictly according to Hoyle, the advantages of VHF reception and visual track indications are a great advance over old-fashioned LF navigation along the same airway.

Original specifications for the ground VOR transmitters accepted a maximum error of 2° or 3°. It was also accepted that large cones of ambiguity (cone of confusion) over the transmitter were acceptable and so were certain errors in airborne reception due to aircraft attitude, *i.e.*, turning, moderate turbulence, etc. Subsequently, ground-station antenna development was such that anticipated error was thought to be reduceable to a ±1°. Additional improvements, combined with allowable receiver error, indicated that an acceptable maximum of ±1.5° justified a minimum flight separation on adjacent airways of 15 miles. What has been the result?

Practical flight testing by agencies charged with the approval of all navigation facilities and the limits or procedures to be applied to their use so far have been unable to approve any enroute segment of Victor airway within anything approaching this 15-mile lane separation except where other factors such as divergent courses apply.

What about passing and climbing through altitudes? This has been one of the major navigation advantages, traffic control-wise, of the VOR system. In the original specification, a 15° lateral separation was established. This was based on the following accepted values of accuracy tolerance:

| | |
|---|---|
| VOR Ground Station | ±2.5° |
| VOR Receiver (airborne) | ±1.5° |
| Pilotage accuracy | ±1.0° |
| Total | ±5.0° |

Diagrammatically, the way the 15° lateral separation would be applied is shown in *Figure 1*.

Subsequent to arriving at the above conclusions and acquiring some experience in the field with practical working equipment not controlled by laboratory and test personnel, serious question was raised as to the validity of this criteria. Reported maximum bearing errors for four types of VOR receivers in current usage were within the following limits:

Receiver Type:

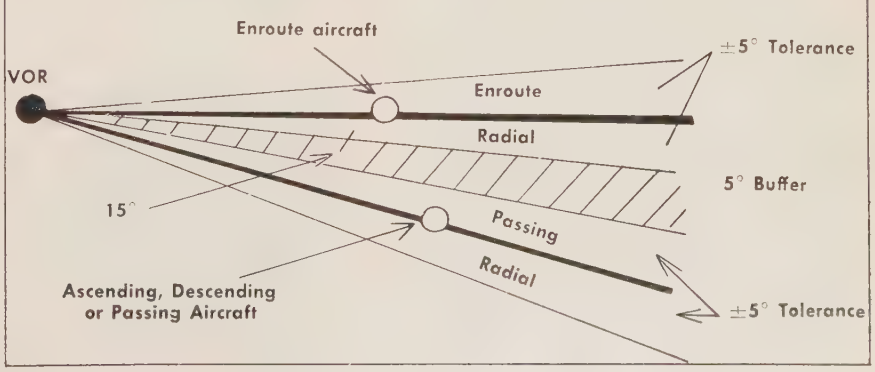
| No. 1 | No. 2 | No. 3 | No. 4 |
|---|---|---|---|
| ±1.8° | ±1.7° | ±4.5° | ±4.5° |

The above figures are the Root Sum Squares of the arithmetic sum of the errors found when employing the following tests:

Standard Operating Conditions. Ambient room temperature and humidity, 30% modulation, reference and variable phase signal frequency of 30 cps, primary power voltage of 27.5 volts and an *RF* input of 1,000 uv.

Variation in Primary Power Supply Voltage, ±10% (commercial power source is considered)

Fig. 1. OPERATIONAL APPLICATION OF 15° LATERAL SEPARATION PROCEDURE



Variation in % Modulation
Variation in Temp. from 0° to 50°C
Variation in RF Input
Detuning

Add to these factors, the optimism of assuming that a pilot will *always* maintain an accurate flight track within ±1.0° and you have the makings of a substantial error.

Enroute along a Victor airway, it is not unreasonable to assume that an average careful pilot will maintain within ±5° of indicated VOR bearing which is safely within width of a VOR airway at average ranges.

When we come to such operations as passing, ascent and descent, however, the utmost diligence must be exercised by the pilot to maintain within ±1.5° of the indicated VOR bearing. At these times, as compared with enroute cruising, he is usually distracted and concerned with other cockpit duties. The greatest threat comes in the process of "holding" where a great deal of ATC work may be involved and an almost irresistible impulse is found to ease out or relax somewhat the holding pattern limits.

It is at times like this that separation criteria between holding patterns in high-density areas break down. Sometimes the evidence is apparent when holdings are being performed for some reason under visual flight conditions, such as on top of an undercast in daylight or moonlight. Both by visual observation and by comparison of holding tracks as viewed on Airport Surveillance Radar screens, no two pilots succeed in making duplicate tracks. Sometimes holding airspeeds are the cause and sometimes it is the result of pilot techniques with respect to rates of turn.

In any case, the problem is dramatically illustrated when, during periods of intermittent good flight visibility, pilots find themselves looking head-on at other aircraft at or near their altitude which obviously are not as far away as both holding and enroute or passing criteria call for!

Another factor which gives cause for concern is the preference of some pilots for the ease of flying brought about by the use of the RMI (Radio Magnetic Indicator) type of instrumentation feeding in the VOR signals automatically. Except for enroute cruising, it would appear that pilots should use the Omni Bearing Selector-Deviation Indicators and employ tighter cockpit discipline at such times as holding, changing altitude or passing. Less likelihood will then develop that they will be startled some day by looking out the side window when navigating in intermittent conditions and spotting some neighboring aircraft uncomfortably close also operating off and on the gauges!

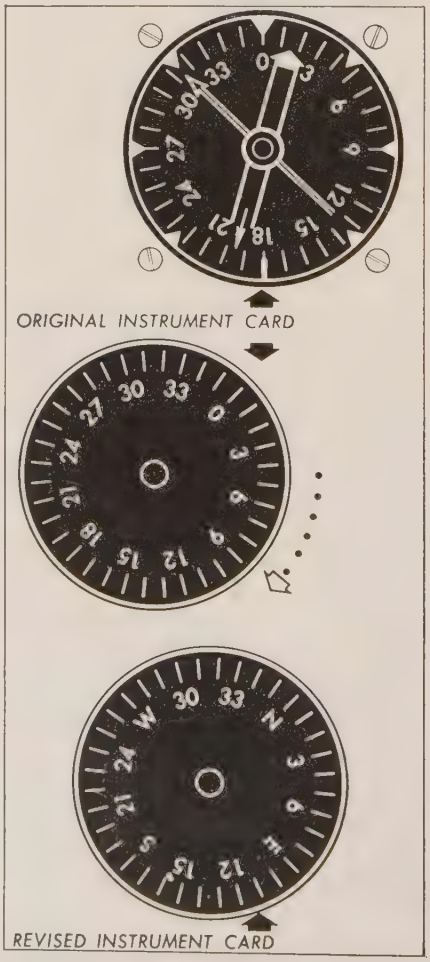
By and large, ATC and Airways Flight Inspection staffs are of the opinion that the present 15° course separation and 15 miles from a VOR station is acceptable *if* a high degree of pilot care and accuracy is assured. In certain specific cases in high-density areas where enroute, climb-out, approach let-down and holding paths are at a premium, safety considerations may demand separation criteria greater than this.

It is no secret that there are no certification standards that apply to an airborne VOR receiver once it is installed, and only pilot/owner concern for its accuracy is a basis for assuming that it remains accurate within the standards prescribed at the time of manufacture.

You as a pilot may be holding an accurate track in an instrument operation. But with the exception of Airport or Area Surveillance Radar there is no check on either the accuracy of the other fellow's equipment or his competence in adhering to accurate track indications!

Self-preservation is probably greatest factor behind the fact that there have not been more than a reasonable number of challenges between pilots in holding patterns or enroute passing or altitude-change operations.

All sorts of means are available for conscientious pilots to check and double-check their airborne VOR equipment and these have been reviewed in both government and industry publications. No one, however, can effectively check the pilot's attitude toward acceptance of less than prescribed accuracies in his equipment. Similarly, it is not an uncommon practice for pilots to succumb to old habits and fly enroute radials slightly to the right (as with old LFRange leg practice) instead of adhering strictly to the designated radial. This results in something less than the prescribed separation for passing and/or altitude-change procedures.




Actual instances have been recorded where pilots have done the latter, or have taken advantage of the omni-navigational aspects of VOR's to cut corners, and less than satisfactory separation has been dramatically revealed. Fortunately, no such incident has yet resulted in more than a "near-miss."

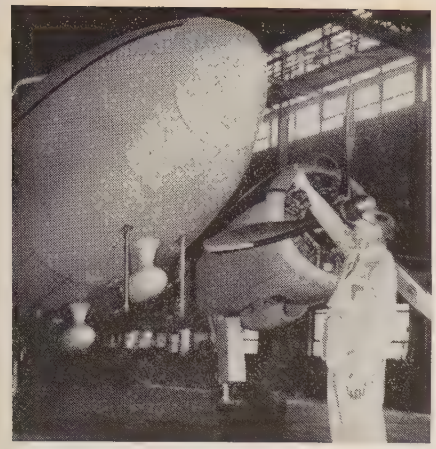
But ATC and local area airspace committees made up of pilot and ATC personnel tear their hair out each time such an incident occurs because more valuable airspace in high-density areas must then be set aside for so-called "buffer zones" between traffic lanes and/or holding patterns to allow for what they can never pin down as navigational equipment error or just plain sloppy flying.

The industry can never go back to the broad separations standards enforced on the old low-frequency color airways. It must take advantage of the more efficient use of airspace offered by the Victor airway system. But like one careless driver on a crowded highway losing control, no aircraft is entirely safe, traffic-wise, while a single pilot neglects his responsibility for using only accurate equipment in an accurate manner.

## Flight Simulator Reveals Errors Made Using "RMI"

From the results of accident investigations and occasional voluntary reporting of non-accident associated incidents, the aviation industry has been able to introduce changes in equipment, installations, and equipment procedures that are, in the real sense, "preventive medicine." Many of these "antidotes" take the form of experience exchange bulletins issued by the Flight Safety Foundation subscribed to by all leading airlines, and other industry associated groups, as well as the general flying public.

One of the latest examples of good preventive medicine is the report that navigational errors made by pilots in operating an airline's flight simulator were attributed to the arrangement of



**RADOME** *developed by Chamberlain Aviation is hinged to forward fuselage section*

the RMI instrument dial. The pilots frequently misread 60° and 90° headings on the Radio Magnetic Indicator when the card was rotated into the lower quadrant. In this position, the figures 6 and 9 on the dial can easily be misread.

Misreading the instrument could induce an off-course error of as much as 30° when pilots were flying a reciprocal using 60° or 90° headings. Errors of this kind could just as readily be made in actual flight during an arduous low instrument-approach procedure under rough conditions, and may have been contributory in the case of some unexplained accidents.

The airline's engineers replaced the dial card with one that eliminated the figure 9 (eliminating confusion with 6) by substituting N, E, S, W for the numerals previously designating these cardinal points of the compass.

## New Radar Nose Offers Unique Advantages

It is a good commentary on the progress of civil aviation in the field of all-weather flying that offerings are now being made to the flying public stressing the advantages of a particular phase of airborne radar installations. Within a very short time radar noses, or radomes, will be as common a sight on executive and other civil transports as ILS, VOR, DME and other antennas.

A new thin wall radome suitable for both X-band and C-band use has just been announced by Chamberlain Aviation Corporation, Akron, Ohio. The new radome is made from multiple-ply Fiberglas cloth, vacuum-bag molded with approved-type resins. All materials conform to applicable government specifications pertaining to radomes, thereby assuring an unusually high transmission rate.

The Chamberlain radome is unique in that it is hinged to the forward fuselage section allowing quick and easy access to the nose compartment. The hinges are amply strong to support the radome in the open position, and the radome is held securely by special lock-and-support pins in the closed position.

Unique, too, is the fact that the Chamberlain radome is supplied in a "packaged" form—complete with all installation parts, drawings, detailed instructions for its installation, together with specific performance data on the radome itself. The radome has an exceptionally high weight-to-strength ratio, undergoing 12 ft. drop tests without marring.

Chamberlain radomes are at present available for Douglas DC-3 type aircraft and *Lodestars*. Other units will be available shortly. For more detailed information, write Mr. J. W. Hale, Chamberlain Aviation Corp., Akron Municipal Airport, Akron, Ohio.

## Many Western LF Ranges Threatened with Shutdown

In a move consistent with the long-standing policy of "phasing out" the Low Frequency Airway system as the Victor (VHF) Airway system shows greater acceptance, the Western Region of CAA has announced the planned shut-down of approximately 35 LF Ranges and ADF homer stations.

In almost all instances, the stations in question are in effect low frequency duplicate facilities to the associated VHF navigational and voice communication and broadcast facilities. Thus, in general they are on routes adequately covered by the equivalent VOR airways. Also, careful surveys have revealed either an overwhelming tendency for the flying public to utilize the VHF facility both in flight plan filing and enroute contacts for progress reports and weather or other flight advisory services. If there is any significant amount of cross-country flying going on that is solely dependent on the LF facilities at these locations, the pilots concerned have kept it carefully secret. (Notwithstanding carefully phrased questionnaire surveys, radio contacts, flight plans indicate preference for VHF facilities.) This being the case, it behooves the CAA to divert the funds required to maintain these LF transmitter sites for expansion of other services shown to be in more public demand.

Taken by area and route, the to-be-shut-down stations are:

ALBUQUERQUE Area—
OTTO, N. Mex., parallel VHF facilities.

DENVER Area—
AKRON, Colo. & LARAMIE, Wyo., both with parallel VHF facilities.

LOS ANGELES Area—
LONG BEACH, PALMDALE & SANTA BARBARA, Cal., all with parallel VHF facilities; NEWHALL, Cal. had no voice facility, neither does its counterpart, FILMORE VORW.

MONTANA Area—
DRUMMOND, LIVINGSTON & WHITEHALL, Mont., all with parallel VHF facilities.

PHOENIX Area—
GILA BEND, Ariz., has parallel VHF facilities.

SAN FRANCISCO Area—
SAN FRANCISCO, Cal., parallel LF & VHF facilities have existed at OAKLAND right along; DONNER SUMMIT & PESCADERO, Cal., no replacement indicated; WILLIAMS, Cal., had no voice but has parallel VHF navigational facility.

SEATTLE Area—
EPHRATA, Wash., has parallel

(*Continued on page* 48)

Next time the missus asks if you've paid your life insurance, tell her you've switched to a **LEAR ARCON** so you can both enjoy the money.

*NEVER fly in instrument weather without an instrument rating!*

**BOWERS BATTERIES**

*Always Better*

BOWERS BATTERY & SPARK PLUG CO., READING, PA.

## Decca for Helicopter

(*Continued from page 15*)

As the aircraft moves relative to the Decca patterns, the stylus automatically records the track of the aircraft on the chart and shows its present position. The display head contains a cassette with a capacity to hold 12 charts which are adequate to cover all the terrain of an aircraft flight, including small-scale charts for airport approach and Air Traffic Control zones.

For aircraft where cockpit panel space is restricted, a different version of the Flight Log has been developed. In this instrument the mechanical principles are different and everything is done in a display unit of 10″ x 8″ x 1⅜″. This display is normally lap-held when checking position and is fitted with a flexible cable so that it may be placed beside the pilot's seat like a map case, where it will continue to plot the aircraft's track. Only one chart is provided, which can be of one scale throughout or can have departure and arrival areas to a large scale and the enroute portion to a smaller scale. The movement of the cursor changes automatically as the dividing lines between different scales on the chart are crossed.

New Decca chains being installed will provide extensive and valuable additions to existing Decca facilities. The India Decca chains are particularly noteworthy in that they mark the first extension of Decca navigational coverage outside Europe.

You bet your life
when you fly
"weather" without a
**LEAR ARCON.**

*NEVER fly in instrument weather without an instrument rating!*

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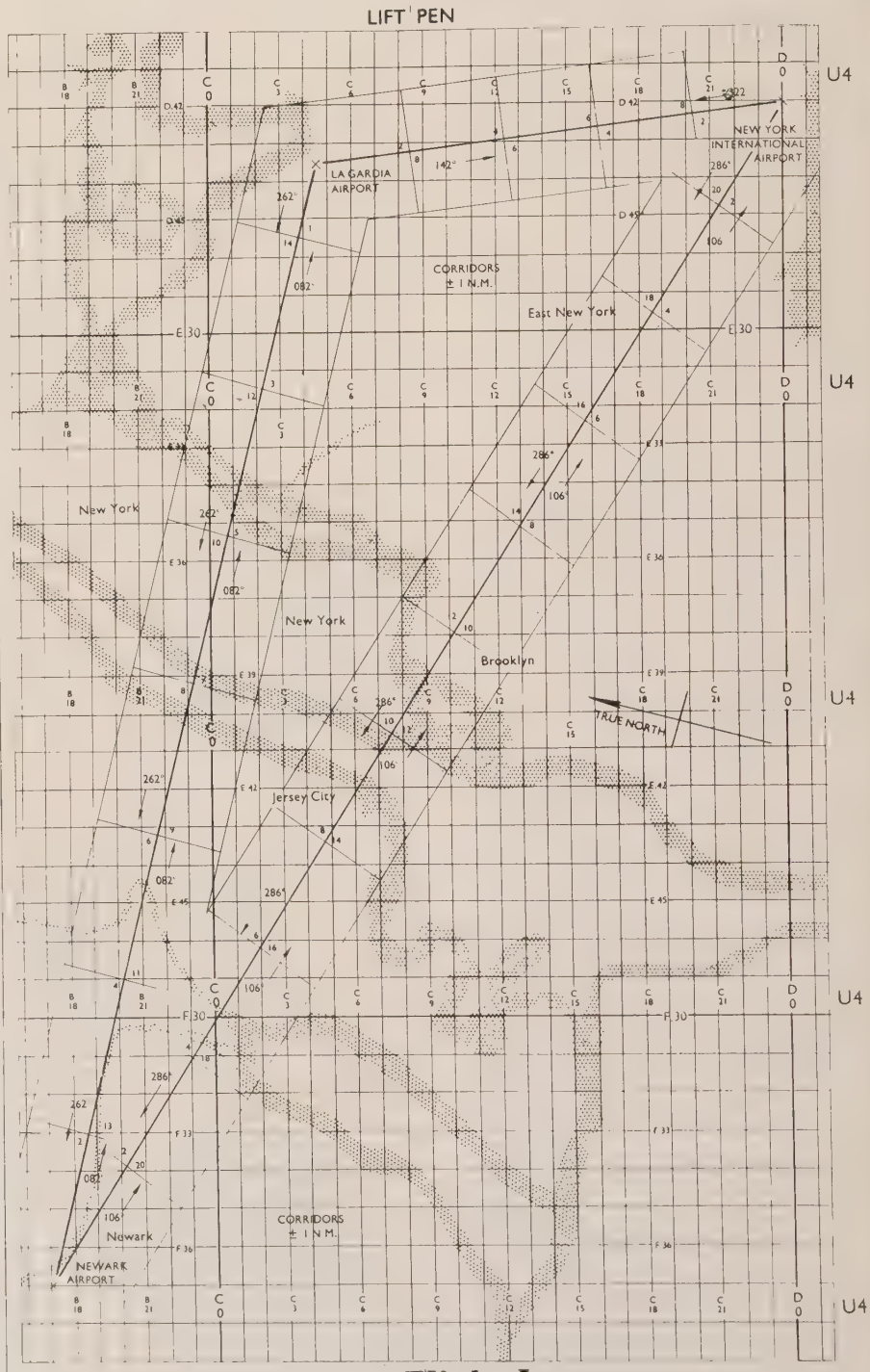
**Flight Operations Round Table**
***For December***
**"Power Requirements of Future Business Aircraft"**




***Decca Flight Log***

## Engine Malfunction

(*Continued from page* 11)

Three seconds per check of "*Left, Both, Right*" is recommended as a minimum, consuming about 10 seconds per engine. Where BMEP gauges are available, BMEP drop will always be observed during mag check, but should be no greater than limits. RPM drop may or may not be observed. Where any doubt exists with respect to engine performance. a full-power runup may be effected, checking for engine smoothness and power output by means of prop load or take-off RPM turn up as well as BMEP indication, if available.

During mag check, intermittent or continuously slightly rough conditions on either mag may be smoothed out after carburetor heat application and/or mixture lean-out, with operation under these conditions for a short period of time at low power settings. Intermittent rough conditions may also smooth out under the same treatment, although a continuously rough engine on mag check probably will not smooth out at all. In all probability the roughness would be due to plug fouling or ignition harness dampness in an individual plug lead to a front or rear plug and would be coupled with a rapid RPM drop equal to or greater than limits. Where roughness cannot be smoothed out, the flight should be delayed to determine the cause. Procedure for determining the bad plug or harness would be to run the engine on the rough mag while taxiing back to the ramp. A cold cylinder should develop, from which the faulty plug or harness can easily be determined. As previously stated, ignition checks always should be made at maximum recommended ignition check manifold pressures, since checking at manifold pressures less than recommended may fail to show up a rough engine. For instance, a failure in a high-tension lead to a distributor allowing short-out might develop only at higher powers. This would result in weak ignition for one set of plugs with probable engine roughness which might not be detected unless enough pressure existed in the cylinders.

A not too uncommon condition of mag check where both plugs in the same cylinder are not firing should be watched for. When the ignition is checked, no appreciable RPM or BMEP drop will be noted. However, some engine roughness and pounding will be noted, the degree of which is about in reverse proportion to the number of cylinders in the engine. An engine with few cylinders will be much rougher than one with many cylinders. This condition would also be accompanied by a considerable variation in RPM in comparison to the normal RPM developed by the engine when the normal mag-check manifold pressure is applied. The loss in RPM, however, might not register if the engine were being run up with the aircraft headed into a strong wind since the RPM would then follow closely that normally experienced on runup. A cross check against the other engine or engines probably would show up the RPM variation at the same manifold pressures. In any event roughness experienced would suggest possibility of a cold cylinder which could be found easily on engine shut-down.

To attempt take-off with a rough engine is tantamount to inviting detonation and pre-ignition in the bad cylinder. This, in turn, is liable to result in failure of the cylinder head, piston or other internal parts or at least the imposition of severe stresses which may cause failure of some part at a later time. Also, where detonation and pre-ignition might develop, complete power loss may be experienced through backfire through the induction system, with possible fire. The initial backfire warnings should be cause for immediate throttling of the faulty engine to lower powers where some power may then be drawn if necessary, provided an induction system fire had not developed. The risks of imposing high power, as on take-off, on a rough engine are not worth taking, and a thorough mag check is the best solution to a fair evaluation of the condition of the ignition system. Needless to say, various grades of fuel usable in the engine will have limitations on maximum allowable manifold pressure which, if exceeded, will cause engine roughness and detonation as though only one plug were firing in a cylinder.

### In-Flight Evaluation

Once the aircraft is airborne, the crew is committed for better or worse to flight with the powerplants at hand. In addition to normal piloting functions, they are confronted with the task of monitoring engine performance and with the responsibility of decisive action in handling any malfunction which might arise. The following

The CAA reports that 561 stall-spin accidents occurred in 1954. Naturally not a single one of these planes was equipped with a **LEAR ARCON.**

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information should be considered in a general sense and not be interpreted in every case presented as the *final word on engine malfunction diagnosis.* It is mainly to familiarize flight personnel with the general symptoms of some engine malfunctions that may be fairly accurately interpreted from observation of the engines, engine instruments, and warning systems.

An alert but relaxed watch should be kept on all engines through occasional visual check of the engines as well as instrumentation checks of all pressures and temperatures. This is particularly mandatory during high-power operation. At night it is a good idea to make an occasional visual engine check with the Aldis lamp or wing-ice lights, particularly after take-off to insure normal engine operation. Symptoms of engine-operation malfunctions may be divided into four general classes: (1) Roughness and Vibration (2) Oil leaks (3) Smoke (4) Fire. Any one of the previously listed symptoms, or any combination of two or more may constitute an emergency.

I. *Engine Roughness and Vibration*

*a.* Although ingition roughness has been covered under engine runup, there are occasions where ignition roughness will occur in flight, and will generally fall into one of four categories, *i.e.,* intermittent or continuously slightly rough, and intermittent or continuously rough. These conditions may show up on both magneto operation. However, they are generally detected during a mag check in flight. Application of carburetor heat and mixture leaning may have an effect in clearing up the condition if caused by plug fouling. Under continuously rough operation on both mags, it may be necessary to reduce power to minimize excessive roughness. Another factor inducing roughness may be high-altitude operation with unpressurized ignition systems where the condition of the plugs and harness is marginal. Pressurized ignition systems should experience little if any trouble at altitude provided normal operation is experienced at lower altitude.

*b.* Engine roughness due to icing is commonly experienced if proper precautions are not taken *i.e.,* applying carburetor heat prior to entering an icing area. Gradual drop in manifold pressure and BMEP will be noted, coupled with roughness and possible backfiring. As a rule of thumb, carburetor icing may be expected in flight operation where the O.A.T is 60° F or below and visible moisture such as clouds or rain is flown through. Carburetor heat up to 100° F should be applied to insure the mixture temperatures remaining above freezing in the venturi area of the carburetor. Carburetor icing in clear air in high humidity is also possible and should be corrected with carburetor-heat application.

*c.* Engine roughness due to mechanical failure in the engine will usually be of a high-frequency, low-amplitude order during the early stages of failures such as piston, cylinder, ring or connecting rod failures, *i.e.,* any failures causing minor unbalance in the engine rotation harmony. This roughness may progress rapidly in amplitude and usually will be accompanied by appropriate indications of power loss and also by possible further visual indications at the engine of smoke or oil or both. Fire feathering procedure should be applied immediately to stop rotation of the engine and preclude development of fire or further engine damage. Although pressing the feathering button should normally feather the engine with minimum of delay, it is possible that the feathering button may have to be pushed several times (as it pops out) to establish feathering under cold temperature and altitude operation because of oil congealing. High propeller RPM will require a great deal more feathering-pump operation than low RPM and may preclude feathering at all, due to the centrifugal twisting moments of the blades tending to maintain the propeller in low pitch and oppose the feathering forces. In some cases it is desirable, therefore, to reduce RPM as much as possible with the prop governor before pushing the feathering button to insure feathering. If the feathering button pops out during the feathering cycle, it should be pushed in again until the

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Ann Neyland
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1953
Valere Duncan
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prop has feathered, *but never held in to prevent popping out* since an unfeathering cycle may be initiated which would aggravate the situation by driving propeller into low pitch.

*d.* Vibration of undetermined origin which cannot readily be assigned to any one engine-propeller combination and which might be of an intermittent or continuous nature, might possibly be determined as to origin by feathering and unfeathering each engine in turn. As each engine is feathered and unfeathered, the malfunctioning engine, when feathered, would clear up the vibration and so should remain feathered, thus avoiding possible further trouble.

II. *Oil Leaks*

*a.* A fairly wide swath of oil coming back over the top of the wing behind an engine nacelle may be indicative of oil coming from an oil-tank filler neck which has been improperly capped by the ground crew. In all probability the rate of oil flow will not be rapid, and there should be no accompanying smoke. Overfilling of an oil tank may also cause excessive oil to be released, spreading over the nacelle and wing, but not as much as in the case of the uncapped tank.

*b.* Oil coming from underneath the wing or nacelle in any appreciable flow in the absence of smoke would probably be an oil cooler core leak. Depending upon the severity of the leak, the engine might or might not be shut down. Oil quantity gauges would determine the rate and amount of oil lost.

*c.* Any leaks of oil that come from the cowl-flap opening probably will be accompanied by puffs of bluish-white smoke and spattering of oil along the nacelle and wing. Generally these symptoms of trouble are good cause for immediate feathering in that the causes for such trouble may be: (1) a blown oil line or an oil line burned through by a hot exhaust flame; (2) probability of a cracked cylinder, heat pumping oil and smoke out of the cowl flap opening; (3) any other type of failure where oil and heat are involved. Sometimes a rocker box oil leak or push rod housing oil leak might be mistaken for a more severe failure in an engine. Generally, these types of leaks result in mild intermittent puffs of gray smoke coming from under the cowl flaps, from one locality, and probably accompanied by a gradual spreading of oil film behind the cowl flaps along the nacelle. These failures are not serious but should be watched carefully since the same symptoms could be applied to beginnings of other types of failures. Also an oil fire might be precipitated with the collection of enough oil in accompaniment with heat.

*d.* Excessive oil from an engine breather probably would result in the engine nacelle being spattered with oil. This type of leak might come from a failed scavenger pump. A piston failure or a piston-ring failure would cause smoke and oil to come from the breather and the engine should be feathered immediately. Oil foaming at altitude should not be mistaken for an engine failure. This condition is evidenced by a voluminous gushing of fine oil spray from the engine breather. The appearance is somewhat similar to a very light smoke.

III. & IV. *Smoke and Fire*

*a.* Intermittent puffs of black smoke coming from an exhaust stack generally can be expected from a fuel-air detonation phenomenon occurring within the engine cylinders. The puffs may be either very light in density or very heavy, and are usually most easily seen off the trailing edge of the wing against a light background. At night the only visible indication of detonation would be the exhaust flame which would appear orange in color and small and sharp in outline. Appropriate action should be taken to reduce the detonating conditions and results cross-checked with cylinder-head temperatures.

*b.* A steady stream of black smoke coming from an exhaust stack may be indicative of a rich mixture. If the smoke stops when the mixture is leaned out, the trouble is obviously a rich mixture condition. These conditions are usually best visible off the trailing edge of the wing.

*c.* A steady stream of white smoke coming from an exhaust stack is reason for immediate feathering of the engine and very careful watch thereafter to determine whether or not any further smoke appears to be coming from the engine, either through the exhaust stack or out from the cowl flaps. Usually this type of white smoke comes by means of an internal failure in the engine which permits oil smoke to be blown out the exhaust stack. The types of failure may be a failed piston, a piston-ring failure, or an internal engine fire. These failures are usually indicated in the cockpit through readings from the engine instruments, such as BMEP loss, but are not necessarily confirmed until fairly obvious symptoms such as white smoke are observed. In any case, careful watch should be made of the engine *after* the feathering operation to make sure further internal and/or external burning of the engine has been checked. Sometimes an exhaust-valve failure may be definitely diagnosed before further damage is done to the engine. Generally, this type of failure results in the piston being battered through which results in characteristic white smoke coming from the exhaust stack, in which case it is time to feather. Such a failure may be caught immediately, however, if the crew notices the characteristic two or three white puffs of smoke that may come from the exhaust stack as the valve just falls and allows the sodium within the valve stem to burn with a short burst of white smoke. There should be definite indication in the cockpit of BMEP drop and tachometer fluc-

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tuation at the same time the smoke is observed.

*d.* A steady stream of bluish-white smoke coming out from around the cowl flaps may possibly be an oil fire in the engine compartment. Feathering is highly desirable in this case with appropriate fire feathering procedure applied. The condition probably will develop from any intermittent smoke-puff condition through a cylinder failure or stack failure or oil line failure and could be further indicated by operation of the fire detection and warning system.

*e.* A steady stream of black smoke coming out around the cowl flaps may be a possible gasoline fire in the engine compartment, and feathering the engine is immediately desirable with accompanying fire feathering procedures. Careful watch of the engine should be maintained to make sure the fire is under control. It is expected that, where installed, the fire-warning lights and detection system would have given advance warning of such a fire. Since in all probability this type of fire would originate from a fuel-line break, anticipation of fuel-line break may be gained through observance of fuel-pressure drop and engine starving when operating on a fueled tank. If application of auxiliary boost pump pressure fails to restore fuel pressure, the engine-driven fuel pump is probably sound and a fuel-line break may be suspected. Appropriate fire feathering procedures should be applied.

*f.* Exhaust stack or collector ring failures generally give forth a gray colored smoke and may be mixed with oil smoke if the exhaust flame should burn through an oil line. The smoke would be seen coming from the cowl flap exit area, and might be accompanied by an audible clacking sound. Feathering and fire-combat procedure is desirable to prevent possibility of an engine fire. Advance warning of such a failure should be detected through operation of the Zone 1 fire warning system.

*g.* Torching should not be confused with engine fires. Torching generally occurs while taxiing or during a landing roll out and is caused by excessively rich mixtures resulting in visible flame at the exhaust stack, whereas flame from an engine fire would come from most any exit such as cowl flaps, or even burn through the engine nacelle. Torching should be cleaned out immediately with throttle when observed, since it is a source of local intense heating and possible fire.

In closing, some consideration should be given to fire-fighting procedures with respect to engine fires. Basic fire-fighting procedure involves three principles, the first and most important of which is, where possible, the removal of combustible or inflammable material or liquids from the inflamed area. This step is very important in engine fires where all fluids should be cut off from the engine. Secondly, a fire may be snuffed out by cooling, that is, lowering the temperature of the combustible material below the ignition point, such as by water saturation; or thirdly, by suffocation or removal of oxygen from the combustible material either by displacement of oxygen with a blanket of $CO_2$ or by blanketing the inflamed area with sufficient material to prevent oxygen reaching the fire. In any engine fire all three of the above mentioned principles would be in one fashion or another. Generally, a power-section fire will be indicated by the Zone 1 fire warning. Following this indication, the engine should be feathered and all fluids such as fuel, oil, hydraulics, and alcohol, shut off to the engine. Feathering, in addition to stopping all operations of the engine and accessories, stops airflow through the engine which would tend to feed a fire, particularly one of the induction-system type. Cutting all fluids from the engine removes inflammable material from the engine. Feathering applies the principle of suffocation. In addition the principle of cooling should be applied by opening the cowl flaps somewhat to allow airflow through the power section for cooling purposes, and also to blow out the fire if possible. An increase in airspeed would be desirable for Zone 1 fires. Where an accessory section or wheel-well fire is indicated by the Zone 2 and 3 fire warning, the same procedures should be applied as for a Zone 1 fire, except that the principle of suffocation should be further applied by release of $CO_2$ to the confined areas. The cooling principle of allowing airflow through the power section by opening cowl flaps should be followed, except that reduced airspeed is desired in order not to dissipate the $CO_2$ from the confined areas as readily as might be done with higher speed. Although the fire is behind the power section, cooling of the power section (cylinders, exhaust stacks, collector ring shield, etc.) would tend to help cool the accessory section and reduce temperatures so that rekindling of the fire after $CO_2$ dissipation would be unlikely. In engines where the power section and accessory section are practically one, that is, where no effective shielding between Zone 1 and 2 exists, cowl flaps should be closed when releasing $CO_2$ to the engine.

Although the basic principles of fire fighting are standard, the procedures of handling engine fires may vary considerably from one type of aircraft-engine combination to another. Also, there are other types of emergencies which may vary considerably from one aircraft to another and for which the procedure of handling will differ or not even apply at all. Therefore, it is important that a thorough emergency checklist be handy in the cockpit which would cover in detail the recommended emergency procedures for various types of emergencies for the particular aircraft-engine combination. Although a primary course of action is usually fairly obvious and well known, there are always secondary courses of action which may be forgotten or not thought of without benefit of a well-ordered emergency checklist prepared for the particular aircraft.


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## TACAN

(*Continued from page 13*)

ously true that TACAN can include ILS components integrated into the airborne equipment as easily as VOR/DME, plus all other accessory items like VHF markers (although DME makes them practically obsolete whether using current or TACAN-version DME), radar safety beacons, etc. In fact, it should be that, designed into the equipment from the beginning, such accessory items should give superior service.

It was clearly inferred that the status of the military ground station installation program is such that by the time civil airborne TACAN units are available in mass production, the airway facilities necessary to make them practical will be ready. Add to this the fact that current DME ground stations are easily and at a reasonable cost convertible to TACAN use (one was done at IT&T's expense to prove this point) and there is good reason to believe the transition, when and if it comes, will be "technically" painless.

A very strong point in favor of TACAN is that the capacity of the ground stations far exceeds current DME. With the present and future congestion around high-density terminal areas, there is good reason to doubt that DME, as operated today, could handle the interrogations of say, 10 years from now! Hence, either DME must be so improved and VOR be made so much more reliably accurate (not as NOTAM'd in every issue of the *Airman's Guide*) that it can handle this future traffic, or TACAN or some even better system must be evolved.

At the present, it is sufficient to state that TACAN *can* handle in excess of four times as many interrogations from separate aircraft as DME. In fact, the ground stations are so set up so that a fairly constant load is maintained regardless of the number of actual aircraft using the station, thus relieving the power supply of fluctuations which might inspire spurious signal-level modulation.

Ease of siting is one of the virtues of TACAN. Notably, VOR has been harassed by the problem of finding sites which were suitable, and more time off the air has been charged to this problem than any other item. In fact, VOR engineers are currently experimenting with tower siting similar to the TACAN, although previous efforts to employ towers to avoid ground influences have been comparatively unsuccessful.

TACAN engineers stated that, although normal siting expectations include provision for better than the 200-mile separation for stations of same frequency, it is quite possible to receive signals from two such stations without confusion except at the moment when signal strength of one station overcomes the other and takes over the indication.

On the demonstration flight previously mentioned, the flight path or track was carefully laid out in advance and no time for any specific requests or off-the-cuff demonstration provided for. Similarly, no time was available to grant request for an overhead check of "the cone of confusion" characteristics. Subsequently, an engineer made the statement that the TACAN cone of confusion is comparable to VOR, or approximately 100° to 110°. As with VOR, they hope to decrease this annoying characteristic.

Turning and twisting of the aircraft, thereby shielding the very impressively small test-tube-like TACAN receiving antenna (unlike the much greater drag-producing VOR/DME antennas) developed the fact that the bearing indication will hold and not go "hunting" for about three seconds, while the range indication will hold for about 10 seconds.

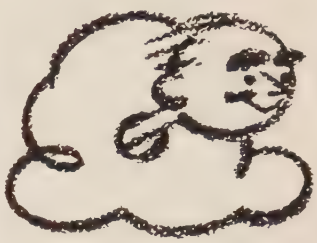
There seems no reason to go off the deep end, either for or against TACAN. If, in the interim period now suggested for further development of both systems, it appears that TACAN has a clear superiority over VOR/DME, it will take little persuasion to get civil aviation here and abroad to make all replacement equipment TACAN.

## Round Table

(*Continued from page* 18)

go. VFR. That would be a borderline situation between operating with pilot only or with a pilot and a copilot, and it would seem to indicate that the answer actually boils down to what kind of an operation you are getting into.

"A pilot flying passengers for hire is in the driver's seat when it comes to deciding whether he goes or doesn't go on a particular flight. He can make up his own mind. If he is familiar enough with the area and can clear out IFR knowing he will be go-

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ing VFR in a few minutes, then he's in a position to know whether or not he can handle the operation. But when we get down to that other category, the private owner who uses a light-twin in his business, the operation would depend on the individual . . . and we can't interpret that from the outside.

"As far as corporate aircraft are concerned, if an organization has invested upwards of $30,000 in a twin-engine airplane, that organization naturally wants utility and that means they are going to have to fly under instrument conditions. If the company has only one pilot, it would be much harder for that one pilot to say 'No' to a flight if he doesn't think he can handle it by himself. If the owner of the aircraft will go along with the pilot's discretion, everything probably would work out. However, if the company expects airline proficiency, then it should definitely have a copilot as well as the pilot.

**Aubrey A. Sweezey** *(Pilot, Federal Telecommunications Laboratories):* "I'd like to ask Art Graham a question.

"With so many pilot-and-copilot flown executive aircraft in the various areas today, do you expect a slow-down stack because of a strange pilot coming into the area?"

**Art Graham:** "There again, I can't generalize on that. We get some light-twins and single-engine aircraft operating with one pilot going in and out of LaGuardia and they handle just as smoothly as the airline aircraft being flown by experienced crews. And every now and then we get a crew in a heavy twin that will foul up the ATC operation. Perhaps the plane's radio equipment isn't operating efficiently or maybe they have had to do their navigation under stress, but no matter the reason some of these boys in the heavy twins need 10 times the handling that a lone pilot in a *Commander* may need. Talking in terms of a one-pilot or two-pilot operation, we have to go back to the weather conditions. The CAA takes no stand other than that expressed in the Civil Air Regulations which, currently, do not require two pilots when operating any aircraft in instrument condition unless it's a nonsked or scheduled air-carrier operation. You can own a DC-3 and fly it with one pilot if you want to.

"Actually, the CAA is reluctant to impose anymore regulations than we already have.

"As to whether or not an aircraft comes in on an approach control operation and ties us up in knots as a result of its having only one pilot instead of two, I don't think we can say. However, if one pilot has to navigate, tune frequencies, handle pre-landing procedures, adjust power, plan for an alternate and a myriad of other things, good judgment would seem to recommend that a second pilot be on hand just to handle the ATC part of the operation."

**Jerry Lederer:** *"Gentlemen, the consensus of opinion then is that the need for a copilot isn't contingent on whether you have one or two engines in an airplane. It's a function of the weather, traffic congestion, and whether it's a day or night operation."*

*"Aubrey Keif, what is your thinking?"*

**Aubrey Keif** *(Mgr., Aviation Division, The Texas Company):* "When we say light-twin, I assume we mean everything up to and including the Twin Beech D18S. I, too, believe that the answer to the copilot or no copilot question lies in how you operate the aircraft and the equipment you have on board, particularly in communications and how easy it is to change frequencies. One pilot properly self-disciplined probably could perform the function of copying his ATC clearances and doing it well. The one thing that is dangerous in having only one pilot aboard an aircraft involves the matter of potential mid-air collision in IFR and more particularly, VFR. One man, no matter how self-disciplined he is, no matter how expert he is or how wonderful his equipment is, is going to have his head inside the cockpit. Having no one to scan the area around his airplane, he is a potential danger not only to himself but to others in the area. The collision hazard is a very serious thing, particularly under VFR, around Chicago and New York. I worry more about this collision business than I do the operation of the aircraft itself."

**Jerry Lederer:** *"That again is true whether you have a single or a multi-engine airplane."*

**Bob Jones:** "There's one thing we haven't talked about yet, and that's pilot judgment. When you get right down to the copilot problem, you can't legislate who should fly what, when and how. Much of it has to be left up to the individual pilot's judgment, and the most important thing on an airplane is the pilot's own neck. He's going to play it on the safe side as much as it's possible. There's only a small lunatic fringe of pilots who will do just about anything, but they are the ones we have to consider. I don't know how much or what you can do to prevent those pilots from killing themselves."

**Baker Bradenbaugh:** "I wonder if any of you fellows who are flying executives around the country have ever thought of checking some of them out on aircraft operation so that in the event of an emergency, they might be able to take over."

**Robert Woodin:** "Where you are operating the smaller aircraft such as our's, and loading conditions being what they are, you seldom have the same executive riding alongside you with anything like the frequency you'd need to accomplish such a thing. Another thing, we endeavor to operate aircraft efficiently and you can't do it if you turn the controls over to your executive passenger and then sit back and watch him fly all over the sky."

**Art Graham:** "Going back for a moment to the economics of it, as Bob Woodin mentioned earlier, occasionally a company pilot who flies a light-twin can't convince either his boss or the company controller that it is advisable for them to give him an additional safety aid in the form of a live pilot. Installing some form of autopilot equipment is a step in the right direction, but most light-twin pilots consider the single-axis autopilots as only halfway measures and they lean more toward full autopilot equipment. There are frequent occasions in flight when you have to copy a clearance and having somebody or something to hold the airplane level on its heading while you're doing the copying, can relieve some of the burden. With this equipment perhaps an air taxi operator should get an operations certificate like other air carriers which will allow him to conduct his operations under certain conditions that might otherwise be considered questionable. I'm speaking, of course, of single-pilot operation. The air taxi operator may find his answer lies in getting this operations certificate that will allow to operate with a single pilot down to certain minimums which have been examined, tested and approved. The executive-aircraft operator could obtain a similar general approval with respect to his operation and place no further burden on the CAA Air Safety Division that today has to approve waiver of minimums for each specific location. The Airways Operation Division, which has to deal with the pilot when he gets on an instrument approach, would benefit also, as the general proficiency level of such operations would rise above the level now experienced with the average non-professional pilot on instrument plan.

"Bob, you're conducting a business operation, and eventually you'll have to come to the point where you operate almost as close to all-weather as the public carriers do."

**Robert Woodin:** "Never, certainly not an air-taxi operation. We've turned down many thousands of dollars worth of business that we legally could have enjoyed if we'd fly night in a single-engine airplane. We don't do it because we don't think it constitutes a safe operation. We feel pretty much the same way about our light-twins. Your company operation regulations are what keep you with a safe operation. We won't hire a pilot, for example, who doesn't have a minimum of 4,000 hours and 500 hours in our type aircraft, the *Bonanza.*

"From the standpoint of economics and our having to fly light-twin equipment, it is true that the regular radio equipment in a DC-6 costs more than a Piper *Apache.* The manufacturers simply haven't made available to us all the necessary equipment in line with our weight limitations. A short time ago we bought a 27-channel transceiver which you can tune without looking at it. It weighs 3.2 pounds and is quite a boon to our operation. We have a VOR receiver which weighs about 3 pounds. That stuff can't weigh anymore than that because, if it does, it's just kicking out payload. As a matter of fact, with the equipment that we have in our twin-engine airplanes, equipment that is necessary for safe operations—flares, fire extinguisher, first aid kit, ADF, VOR, a spare transmitter, an extra LF receiver, and a rotary beacon, we're down to a mere 22 pounds baggage allowance in our airplane."

**Jerry Lederer:** *"What equipment would enable you to replace the need for a copilot? For example, in the matter of collision that Aubrey Keif brought up, if we had a Doppler-type radar system, then you could put your face down in the cockpit and be entirely safe, because you could have a circuit included that would make a bell ring to alert you if you are on a collision course with another plane. Or you could use a Zero Reader to help in plane operation, or the Speed Control system, an autopilot, etc."*

**Robert Woodin:** "Practically everything you do in planning a flight, going on a flight, etc., can be pre-planned. In our operation in this New York metropolitan area we have a streamlined planning system for just about every conceivable thing that

ou can do with an airplane, all the way rom how much we're going to charge to ake a person from this point to that, to epartures and procedures that will keep our head in the cockpit much less time. m talking about under 7500 gross, not ncluding the Twin Beech.

"There is no substitute for two things—xperience and keeping your neck on a wivel. A lot can be eliminated that would empt you to do paper work or look at the harts if you have a properly prepared rganization. For example, our pilots know ll frequencies every Outer and Inner narker, every ILS, Glide Path and range tation in the metropolitan area for VFR se."

**Rip Strong:** "But how about when you o to Chicago or Boston? Your operation s limited to the metropolitan area. My peration might be Los Angeles tomorrow, Atlanta the next day, etc."

**Bob Jones:** "One thing that might be one to alleviate this condition, not right ow perhaps, but certainly for the future, would be to make instruments that you on't have to look at unless something oes wrong. That would certainly reduce ilot tension. With radio equipment, for xample, perhaps you could dial the fre-uencies instead of having to turn on witches, etc. Many things could be more utomatic, thus making an airplane easier o fly and giving the pilot more time to ook out for other things, other airplanes."

**Aubrey Keif:** "I wonder if we aren't put-ing too much emphasis on two men in the ront office of a light-twin in and around erminals. Sometimes I worry about en-oute flight. It's amazing how many near-ollisions are experienced when you are out n the open. Maybe we need just what erry suggested, a radar device that would ing a bell."

**Aubrey Sweezey:** "I don't think having wo pilots is a guaranteed safety factor. think it's a matter of how two men cross-vork in the cockpit. When one is tuning n the communications equipment, the ther should be looking out. Frankly, all he mid-air collisions I can think of were etween aircraft utilizing two pilots."

**Jerry Lederer:** *"That goes back to Mr. Woodin's idea of the necessity of having a good procedure."*

**Aubrey Sweezey:** "Seems to me that some ime ago a plan was devised whereby the mage of your instruments was reflected n the windshield and you wouldn't have o have your head down and locked in the ockpit."

**Jerry Lederer:** *"That was Glowmeter, I believe. What would you fellows think of aving a light tape recorder in the cockpit o record clearances?"*

**Art Graham:** "That would be fine if it would be used. Some business pilots, air-ine pilots and private pilots copy clear-nces, and others do not. If the recorder were tapped into the radio and wouldn't equire any other manipulation and could be mmediately read back, reviewed, etc., I'd ee no objection to it. It'd be fine.

"The question is, will it introduce further omplications and more of a burden on the rew than the single notation or jotting f a single pilot? It may be that when a ilot is flying alone, he'd have to switch n the recorder to play back and listen to at a time when ATC is calling him. That would create more of a situation than a help."

**Baker Bradenbaugh:** "The Navy used a mike that rested on a carrier phone. All you had to do was swing it down into place, press a button and talk into it. You didn't have to reach all over the place for a microphone. Why don't the business pilots use something like that?"

**Rip Strong:** "Most executive aircraft use speakers in the cockpit. We don't use headsets."

"Awhile back, Art mentioned the way controllers read clearances to crews, a mile-a-minute, he said, because of the pressure on them. When the controller rattles off a clearance that way and my boy in the cockpit can't copy it down fast enough, gets confused and has to call for a repeat on it, that takes up a lot of time and adds to the controller's pressure. Wouldn't it simplify things if the controller read it at a normal rate in the first place?"

**Art Graham:** "I'm glad you brought that up because it's one of the problems we deal with all the time in this high-density area where, even in VFR operations, you have more contacts on a simplex frequency than you can handle in the allowable radio time. Although our procedures are designed to cut everything down to a minimum, we rely on standard phraseology and hope that only those situations that can be met by standard phraseology will have to be dealt with. We try to handle perhaps 90 to 96 aircraft an hour and that means we have 40 seconds per aircraft for maximum runway utilization, bring them all in and keep them separated within a three to five-mile area, and we have to give them a sequence

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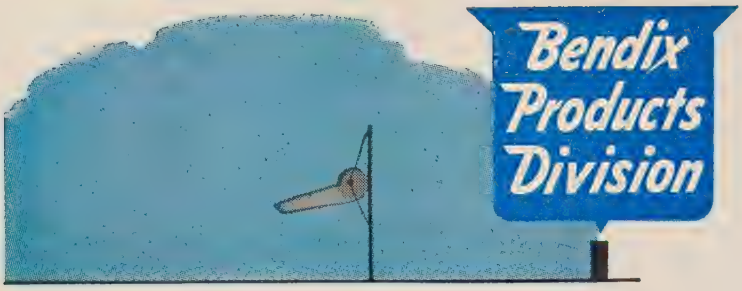


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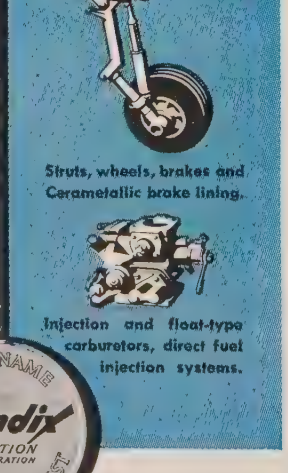
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early enough to allow them to pick up the fellow they have to follow.'

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**Rip Strong:** "I was just wondering why the ground control clearances can't be transmitted a little slower so it wouldn't necessitate calling back the ground controller to have the clearance re-read."

**Art Graham:** "The problem of Ground Control on the airport has become such that it is now considered one of the toughest positions to handle for a controller. The reason is that along with these ATC clearances, we have numerous amendments which must be delivered, plus complete climb-out instructions, and the separating of traffic on limited taxi routes past congested gates and taxi strips. Due to aircraft going out on different routes, we must bypass aircraft that can't get clearance and have ATC holds and we must also expedite, the clearing of aircraft going off the active runway to open the taxi strips for other close-in landing aircraft. With all that, the radio congestion on ground control has become as much of a problem as the radio congestion in the air. Even though we try to slow up our rate of transmission, it automatically goes up again as the rate of traffic and pressures increase. Very often a stranger coming in or going out of the N. Y. area has to ask us to repeat his clearance. We aren't at all adverse to having a pilot ask us for that repeat or to read it more slowly. We'll take the time, but that time is a penalty."

**Rip Strong:** "What about unnecessary phraseology, such as when either my co-pilot or I will acknowledge a clearance or instruction and say, 'Okay, will do,' or something like that? All those added words could be left out of the conversation and it would certainly give you boys some extra time, particularly if everybody would co operate."

**Art Graham:** "I don't know what else can be eliminated and still not sacrifice safety. General safety procedures require a pilot, whether he be an airline or an executive pilot, to read back a clearance, and in many instances it's been found that a pilot thought he heard something or other than what was actually said to him, and the read-back is the only check possible. It's very important.

"I don't know how you can cut down on this increasing complexity and radio jamming in and out of terminal high-density areas, what with routings, courses, headings to be followed, altitudes at which to cross certain fixes, etc."

**Rip Strong:** "Frankly, I'd never feel safe in my own mind in taking off without a read-back of the clearance."

**Bob Jones:** "Taking a look at the New York area chart, it's a wonder airplanes move in and out of the area so successfully. It would seem to me that if everyone got together and worked out something like the one-way street system used here in the city, then there wouldn't be the criss-crossing all over the place. Maybe the CAA, the airlines, etc., should figure out a better way of getting in and out of the terminal areas around the country. That would make for a better operation with either one or two pilots."

**Aubrey Keif:** "Art, can you tell us what sort of twin-engine aircraft goes in and out of LaGuardia and has only one pilot, and do you know of any incidents that may have occurred because there was only one pilot in the cockpit?"

**Art Graham:** "We only have access to information of that nature if an incident occurs and our attention is specifically drawn to the fact that the aircraft involved was operating with just one pilot. Even if you had that information, I don't think you could draw any definite conclusions because the incident might have been the result of faulty equipment, the inefficiency of the individual pilot or perhaps even the controller. If, over a period of time, you found that such incidents occurred more frequently with a single-pilot operation than a two-pilot operation, then some conclusion could be drawn."

**Rip Strong:** "What position do insurance companies take on this matter of operating light-twins with or without co-pilots? Does it make any difference in the rate?"

**Baker Bradenbaugh:** "Not directly, although the fact that a light-twin is being operated with both pilot and copilot is taken into consideration when the rate is originally developed. There are many factors involved in the establishment of an insurance rate: the type of airplane, its value, where it is going to be operated, how many hours a year, etc. All of these factors enter into the making up of a rate."

**W. D. Crawford:** "From my looking around the countryside, I'd say that only a very small percentage of the corporate-owned light-twins are flown by a pilot with a copilot. If our loss experience with this group is poor, it will be reflected in the rate and you are going to have to pay more money at a later date."

**Rip Strong:** "The insurance company wouldn't refuse to insure that airplane?"

**W. D. Crawford:** "If there were a specific case in which we knew that one man was going to fly in heavy instrument conditions, we probably would."

**Bob Jones:** "I think that the pilot who is now flying instruments on a single-engine airplane is not going to take off under low minimums when he's flying a light-twin. However, I do worry about the fellow who is just beginning to fly instruments. He may want to get his feet wet in this instrument business if he's flying a light-twin, and that is where some if the danger lies."

**Jerry Lederer:** *"Gentlemen, this has been a most interesting discussion, and I'd like to close it with a statistic. Your last comments relate to the difference between a professional and a non-professional pilot. The non-professional pilot has a fatality rate that is about six times that of the professional pilot!*

*"By way of conclusions, we seem to agree that:*

*"1. It is a combination of factors rather than the airplane itself which determines whether a copilot should be carried. These factors are traffic congestion, weather, aircraft complexity, handling characteristics (especially on one engine), approach speeds, radio traffic, range, etc.*

*"2. Aircraft of the heavy class (Lodestar, DC-3) should have copilots.*

*"3. A well-trained pilot, experienced in the regions in which he operates, can safely operate light-twins under carefully imposed operating restrictions and by thorough pre-flight planning, even in areas of high density.*

*"4. A copilot, however, is highly desirable to assist with communications in areas of high traffic density, and to keep watch for collisions at all times provided the pilot-copilot combination acts as a well-trained team. But in light-twins controls are not accessible to copilot* (i.e. *radio*).

*"5. The installation of light weight reliable aids such as automatic collision-warning, Zero Readers, etc. would reduce the need for a copilot on light-twins.*

*"Gentlemen, thank you for your excellent* contributions to this Round Table."

## NBAA

(*Continued from page* 30)

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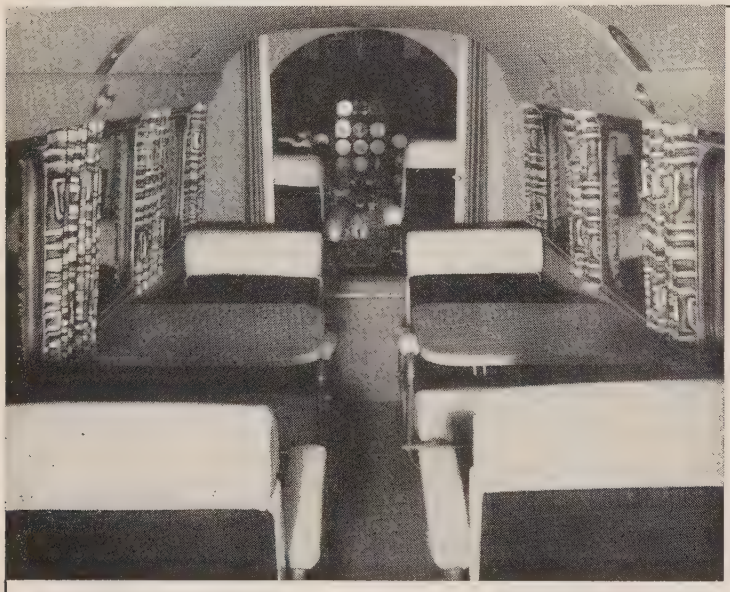

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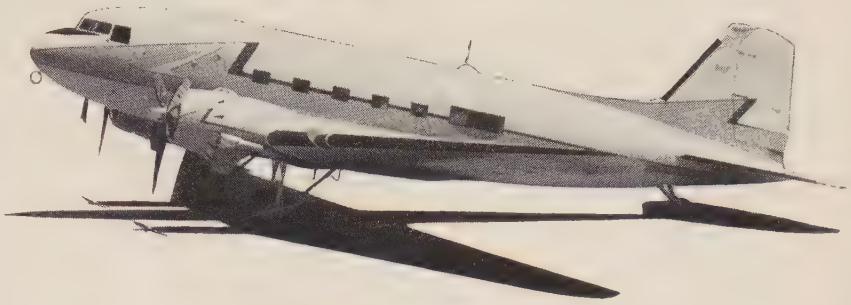

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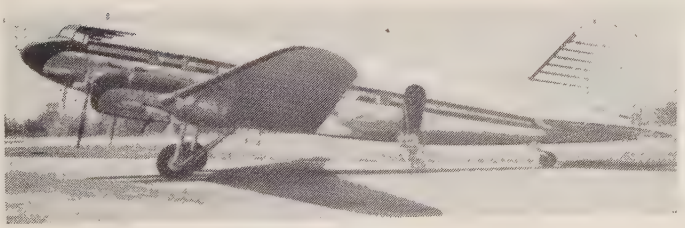

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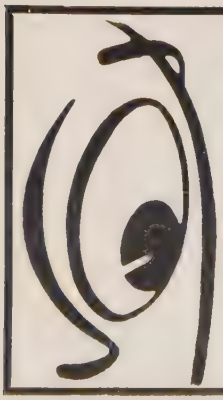

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## NAVICOM

(*Continued from page 33*)

VHF facilities; TOLEDO & SHELTON, Wash., the misplaced and voiceless OLYMPIA VOR is no replacement for these two facilities.

SALT LAKE CITY Area—
FORT BRIDGER, Wyo., POCATELLO, Ida., SALT LAKE CITY & WENDOVER, Utah all have parallel VHF facilities; FAIRFIELD & LUCIN, Utah had no voice facilities, neighboring VORW's will supply navigation facility

SEATTLE TO SALT LAKE via GREEN AIRWAY 10—BAKER, Ore. & GOODING, Ida. have equivalent VHF facilities except for lack of voice on TWIN FALLS VORW.

SAN FRANCISCO TO SALT LAKE CITY via GREEN AIRWAY 3—
BATTLE MOUNTAIN, Nev., has parallel VHF facility.

SAN FRANCISCO to SEATTLE—
EUGENE, Ore., & FORT JONES, Cal., both have parallel VHF facilities. WHITMORE, Cal., had no voice facility and reliance is placed on KLAMATH FALLS & RED BLUFF VOR's for navigation.

ARCATA, Cal.—
Nearby FORTUNA, Cal., VOR is the parallel facility.

LAS VEGAS, Nev. to SALT LAKE CITY—
Loss of ENTERPRISE as voice facility not supplied by neighboring VORW's at MILFORD & MORMON MESA, on AMBER AIRWAY 2.

HOBBS, N. Mex.—
Has parallel VHF facility.

NEEDLES, Cal.—
Has parallel VHF facility on heavily traveled GREEN AIRWAY 4.

It is possibly a good idea to circle these facility locations on your charts, as a reminder to check their status when pre-flight planning in this area.

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**AERONAUTICAL PUBLICATIONS (Cont'd)**

"Ground Instructor $5.00"; "Parachute Rigger $4.00"; "Control Tower Operator $4.00"; "New CAR for pilots 50¢." Special Limited Offer; A complete Ross Library consisting of the above 12 books for only $15.00. This introductory offer is for a limited time only, so take advantage of its savings today! Order Postpaid or C.O.D., Direct from Ross Aero Publishers, Administration Bldg., Box 7071S, Cherokee Airport, Tulsa, Oklahoma.

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**FOR COMPLETE** market reports of available Beech, Convair, Curtiss, Douglas, Grumman, Lockheed or other multi-engine aircraft, write or call William C. Wold Associates, 516 Fifth Ave., New York 36, N. Y., Telephone Murray Hill 7-2050.

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**WANTED—AIRCRAFT RADIO MECHANIC** Experienced on Collins, A. R. C., Lear. Openings for top qualified personnel. Atlantic Aviation Corporation, Teterboro Airport, Teterboro, N. J. HA 8-1740.

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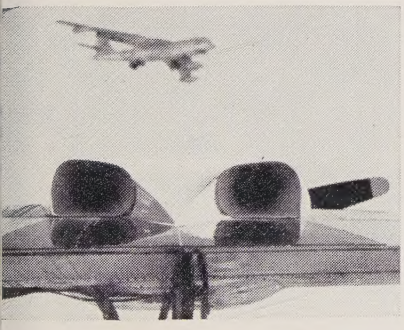
First Businessliner boasting a top speed of over 220 m.p.h., Cessna's new 5-place 310, with space for 200 lbs. luggage, sets new standards as the ...

# *Fastest Business Twin*

## Speed with a purpose

Two 240 h.p. engines give the 310 a cruising speed over 205 m.p.h., make it the fastest executive twin. Airplane's primary purpose: safe, fast service for businessmen on the go! The all-new 310 carries five passengers over 1,640 miles in a single day,* gives business a new flexibility.



## Climbs on one engine

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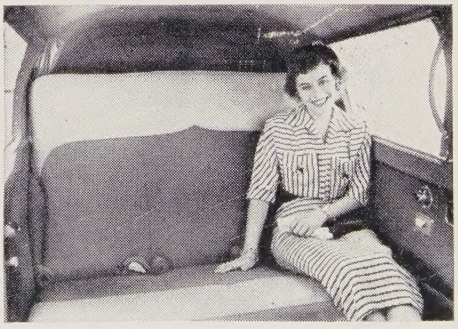
Planned for flying comfort, this luxurious all-metal twin has wide, foam-rubber adjustable rear seats, adjustable and reclining front seats. Interior colors match stunning exterior color combinations. 200-lb. luggage compartment is reached through cabin or outside door. Full heating-ventilating system with 8 outlets and defroster.



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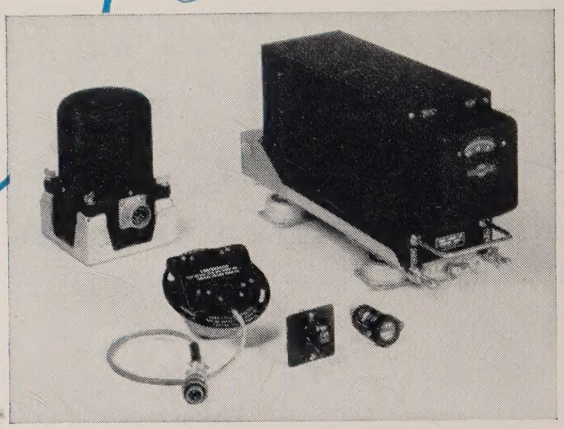

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Combining the high sensitivity of a modern earth inductor with reliable magnetic amplifiers, Collins engineers have developed the MC-101 system which produces highly accurate heading information. Flight panel simplification is achieved by presenting Heading on an azimuth ring or RMI card. The Remote Master Heading Indicator is included on the Compass Amplifier. By use of a single control the pilot can select automatic or D/G functions, and can manually correct the D/G left or right.

No additional amplifiers are needed. Three transmitters in addition to the D/G transmitter provide more than adequate system output as well as electrical isolation between various heading loads. It can be used with a/c navigational units, like the 51R-3, OBS and OBI instruments, and systems such as Collins IFS and Automatic Pilot. Modular construction, with the advantages of plug-in subassemblies, provides the utmost in flexibility and servicing convenience.

*Write for MC-101 brochure or contact the Collins Dealer or Sales Office nearest you.*

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